A Report to The President

Control of Agriculture - Related Pollution

Submitted by
The Secretary of Agriculture
and
The Director of the
Office of Science and Technology

Washington, D.C. January 1969

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January 15, 1969

The President
The White House
Washington, D. C. 20500

Dear Mr. President:

We are pleased to submit to you a report entitled "Control of Agriculture-Related Pollution." It was prepared in response to a directive in your Message to the Congress of the United States on March 8, 1968, titled "To Renew a Nation." Federal agencies concerned with problems of agricultural wastes contributed to the report.

We believe this document will be of substantial value to those engaged in program planning and development, legislative activities, and management of the environment in general. It should be especially helpful to those involved in research and action programs dealing with agriculture-related pollution.

Respectfully,

Secretary of Agriculture

Acting Director, Office of Science and Technology

F O R E W O R D

The March 8, 1968, Presidential message, "To Renew A Nation," included a directive to the Secretary of Agriculture to conduct a government-wide review of agricultural waste problems.

Prior to this message, the Office of Science and Technology (OST) had expressed an interest in agriculture-related pollution and had initiated interdepartmental discussion on the subject. The Secretary of Agriculture requested that this activity be expanded to fulfill the requirements of the Presidential directive. Accordingly, a study was undertaken under the direction of OST with the following Federal Departments participating--

Agriculture (USDA)	Housing and Urban Development (DHUD)
Commerce (DOC)	Interior (USDI)
Defense (DOD)	Transportation (DOT)
Health, Education, and Welfare (DHEW)	

The activities of the Tennessee Valley Authority were not included.

Eight major pollutants or carriers were studied.

This report is limited to Federal responsibilities in "agriculture-related pollution."

Though these Federal responsibilities are extensive and involve several Departments, they are only a part of the total national effort required to control pollution. State and local governments, universities, foundations, industries, and individual citizens have vital roles in solving environmental problems.

Efforts for controlling agriculture-related pollution must be coordinated with those for controlling urban and industrial pollution to insure maximum environmental improvement. Ultimate responsibility for preventing, controlling, and abating agriculture-related pollution rests with individual farmers, ranchers, feedlot operators, and forest owners and with the industries processing animal, crop, and tree products.

This report is submitted jointly by the Department of Agriculture and the Office of Science and Technology. The cooperation of the participating Departments in submitting information for this report is acknowledged and appreciated. It is evident that several of these Departments have major responsibilities for developing and conducting programs in the subject area.

C o n t e n t s

I N T R O D U C T I O N

Quality of the environment is of vital concern to every segment of society. Although the concept of environmental quality is difficult to define, the absence of quality is easily recognized.

Environmental pollution is the unfavorable alteration of our surroundings through direct or indirect effects on the chemical, physical, and biological characteristics of our air, land, and water, influenced primarily by man's actions.

Programs for improving environmental quality must aim at preventing further deterioration and at restoring the quality to a socio-economically acceptable level.

This report is concerned with problems and programs dealing with air, soil, and water pollution in relation to agriculture and agriculture-related industries. It considers the complete agricultural system associated with farm, forest, and other land areas. This includes such things as food and fiber production, processing, transportation, and marketing; recreation; source water for streamflow; and wildlife habitat. The report gives attention to agriculture as it contributes to pollution and as it in turn is affected by pollution.

Agriculture-related pollution is but one part of a large national problem. It must be considered together with municipal, industrial, mining, marine, and other types of pollution in developing an integrated effort for improving the quality of our environment.

In this report eight pollutants of special concern are discussed, each in its own section--

Sediment
Animal wastes
Wastes from industrial processing of raw agricultural products
Plant nutrients
Forest and crop residues
Inorganic salts and minerals
Pesticides in the environment
Air pollution in relation to agriculture

Other pollutants related to agriculture are discussed but not in separate sections. These are radiation, infectious agents, toxins, allergens, noise, and heat.

Sediment

From the standpoint of quantity, sediment resulting from the erosion of land is the greatest contributor to pollution of surface waters. The effect of this pollution by sediment is expressed in the impairment of the quality of the water and the damage caused where the sediment comes to rest. The harmful effects are many--some physical, some chemical, some biological.

The prevention and control of sediment may be accomplished largely by the control of its source--erosion. The following areas of emphasis are considered essential in meeting the goal of preventing and controlling undesirable sedimentation--

1. Minimizing soil erosion and curbing sediment delivery from agricultural, range, and forest lands

2. Controlling sediment in stream channel systems

3. Controlling sediment from erosion along rural roads under local control and in connection with all highway and road construction programs

4. Controlling sediment derived from erosion of abandoned surface mines within the context of mine-waste control

5. Assisting local governments in effective erosion and sedimentation control in urban and industrial developments

Animal Wastes

The volume of wastes from livestock and poultry production is estimated at 1.7 billion tons annually. About one-half of this amount is produced by animals in concentrated production systems. The degree of concentration and the size of individual production units are increasing rapidly. This trend permits greater efficiency in the production of animal products but also results in a need for new technology in handling and disposing of wastes in a manner that is compatible with public restrictions set up to avoid pollution.

Animal wastes are a concern in the abatement of water, air, and soil pollution. They are associated with eutrophication of lakes, fish kills, nitrate contamination of soil and aquifers, off flavors, annoying odors and dusts, dissemination of agents infectious to animals and man, depreciation of recreational values of rural land and streams, and reproduction of insect pests.

A research and action program for controlling animal wastes involves minimizing pollution by improved use of existing technology as well as by developing new and improved--

1. Animal-management methods and facility design

2. Waste treatment and disposal methods

3. Methods for converting wastes to useful products

It also involves

4. Minimizing pollution through (a) assisting in the establishment and enforcement of standards and (b) providing criteria for land use planning

Wastes from Industrial Processing of Raw Agricultural Products

In processing raw agricultural products to food, textiles, leather, pulp, paper, wood products, and industrial chemicals there are inevitable losses of organic and inorganic matter, ranging from a very small percentage of the amount processed to as much as 25 to 50 percent of the raw material entering the plant.

Processing of farm products for food is the principal agricultural processing industry. Almost 18,000 industrial establishments are at present engaged in this activity. Processing of forest products also results in the production of wastes. The pulp and paper industry is large, and the size of individual plants makes the problems of stream and air pollution from them especially noticeable.

Cotton and wool processing dominate the textile industry. Leather and soap manufacture and the production of industrial chemicals from farm and forest products and byproducts are other important industries that produce pollutants in the course of their operations.

The estimated total load of pollutants produced by the agricultural processing industries is greater than that from a population of 168 million people.

The following four areas of emphasis were used to analyze present and needed programs--

1. Modernization of harvesting and processing

2. Byproduct recovery and utilization

3. Treatment and disposal of wastes from processing plants

4. Changes to make agricultural raw materials that are more readily processed

Plant Nutrients

In 1967, 39 million tons of chemical fertilizers were applied in the United States and further large increases in use are projected. The principal nutrients supplied were nitrogen, phosphorus, and potassium. In surface waters, an overabundance of these nutrients, particularly nitrogen and phosphorus, contributes to excessive growth of algae and other aquatic plants, adversely affecting water quality for fish, recreational use, and human consumption. Nitrate nitrogen is highly mobile and can enter ground and surface waters. Phosphorus and potassium are carried on eroded soil particles and are deposited in sediments of streams and surface water systems. Control of losses from agricultural land can be improved.

To accomplish the needed control, emphasis is needed in research and action programs on--

1. Behavior and fate of applied nitrogen, phosphorus, and other nutrients

2. Minimizing runoff and percolation of nutrients by using them more effectively

3. Controlling, treating, or removing excess plant nutrients from surface or subsurface drainage to maintain the desired quality of receiving waters

4. Effects of nutrients on algae and noxious water plants

5. Use of harvested algae and other water plants

Forest and Crop Residues

Forest and crop residues serve as a reservoir of plant diseases, insects, and rodents and, if burned, contribute to air pollution. These residues are from harvesting operations and from accumulations resulting from pest damage or natural deterioration. Some of these residues are useful if left on the area and properly treated. Others such as logging debris are serious problems because of the fire hazard they create or because they are hosts for diseases and insects.

Forest and crop residues can be serious contributors to air, soil, and water pollution. There is much that can be done to prevent or alleviate the problems they create.

Consideration is given to current and future programs for--

1. Minimizing production of undesirable forest and crop wastes

2. Improving utilization of forest and crop residues

3. Treating or removing hazardous or excessive forest and crop residues in the environment

4. Assisting local areas in developing guidelines and control programs to govern the disposal of forest and crop residues

Inorganic Salts and Minerals

All streams contain dissolved inorganic salts and minerals. If the water is diverted for irrigation, the dissolved salts are concentrated by evapotranspiration and either accumulate in the soil or reenter the stream in concentrated form in the return flow. Salt concentration in the stream is therefore increased with each use of its waters. The problem is most important in the arid parts of the Nation.

Pollution by inorganic salts and minerals can be reduced by programs designed for--

1. Decreasing salt concentration of the irrigation supply source

2. Improving irrigation and drainage practices to minimize the effects of salts and minerals on soils and return-water quality

3. Treating or disposing of salts and minerals in return flows

4. Improving plant tolerance and utilization of salts and minerals

Pesticides in the Environment

Pesticides become pollutants when they, their metabolites, or degradation products remain in the environment after the desired purpose has been accomplished or if they reach some part of the environment other than the intended target. Pesticides vary in the amount of such pollution they produce, depending on their persistence and final disposition. Persistent pesticides that accumulate in a part of the environment, such as soil, water, air, or animal tissue, are of particular concern.

Much of the knowledge of the nature, extent, and significance of pesticides in the ecosystem is fragmentary and is derived from studies designed for other purposes. Intensive cooperative studies are required to more fully evaluate the impact of pesticides on the environment. These studies should involve large areas of the environment and will require the joint efforts of several major Departments.

The following areas of emphasis are given major attention--

1. Evaluating the nature, extent, significance, and impact of pesticides in the ecosystem

2. Reducing the amount of hazardous pesticides in the environment

3. Treating, controlling, or removing pesticides from soil, air, and receiving waters

4. Disposing of pesticide wastes, including used pesticide containers, in a manner least detrimental to the environment

5. Assisting State regulatory agencies in the establishment of uniform effective pesticide regulatory programs

Air Pollution in Relation to Agriculture

Air pollution has become a problem of great national concern. Agriculture is directly concerned because of air pollution damage to crops, forests, animals, equipment, and facilities and because of the contribution of agricultural enterprises to air pollution. The extent, severity, and kinds of damage are determined largely by the kind, concentration, and location of pollutant sources, the interaction of pollutants, and the susceptibility of a crop or animal at any given time.

Many air pollutants now considered serious will eventually be controlled at the source, but it is becoming evident that photochemical reactions pose the greatest air pollution threat to agriculture.

Agriculture related contributions to air pollution include fumes, odors, and smoke from processing plants, weed pollen, burning of crop residues, and forest fires.

The following areas of emphasis indicate where additional research and action programs are needed to advance our knowledge and capabilities.

1. Measurement and monitoring of air pollutants

2. Effects on plants and animals

3. Economic impact

4. Genetic and environmental control

5. Control of agricultural air-pollution sources

SEDIMENT

It is extremely difficult to determine the part of sediment-related activities that can be allocated specifically to antipollution goals. Prevention and control programs have other primary objectives, such as soil conservation to maintain agricultural productivity and roadbank and riverbank stabilization to maintain the integrity of land, roads, channels, levees, floodwalls, and other facilities and structures.

The results of the study of sediment must be considered in the light of the following reservations.

1. Control of coastal and Great Lakes shore erosion is specifically excluded.

2. Sediment control is practiced to accomplish many objectives of which pollution control is one. The assignment of parts of these programs to sediment control is largely arbitrary and subjective. Although an attempt has been made in this direction, the results must be considered as rough estimates that provide an indication of order of magnitude rather than detailed accuracy.

SEDIMENT

I. The Problem

Sediment can be defined as solid material, both mineral and organic, that is being transported or has been moved from its site of origin by water, ice, air, or gravity. In this section only mineral sediment is considered--primarily that which is moved by water.

The greatest quantity of pollutants in surface waters is the sediment produced by erosion of the land. On the average probably at least 4 billion tons of soil material are moved from place each year, transported by flowing water, and deposited at another location. About one-fourth of this material, or more than one billion tons of sediment, reaches the major streams of the United States annually from agricultural and other sources.

Of the 2,266 million acres in the United States, approximately 1,846 million acres are cropland, rangeland, and forestland, a large part of which is subject to erosion. Of the remaining 420 million acres, 143 million are devoted to transportation and residential, commercial, industrial, and other special uses, and 277 million are marsh, swamp, bare rock, desert, and tundra (table 1).

The principal sources of sediment are (a) sheet erosion by surface runoff in which soil is more or less uniformly removed from an area without the formation of conspicuous water channels; (b) gullying or the formation of channels in soil by concentrated runoff; (c) roadside erosion or the washing away of material from cuts, fills, and surfaces of transportation lines; (d) stream channel erosion; (e) flood erosion or the scouring of flood-plain land by floodflows; (f) erosion from construction activities such as those in urbanization and industrial development; (g) mining and industrial wastes dumped into streams or left in positions susceptible to erosion; and (h) mass wasting from landslides.

Soil erosion and its effects are damaging many times over. First, there is the irreparable loss of soil that usually has taken many thousands of years to form. Second, sediments not only contribute heavily to suspended-solids pollution but also add to the dissolved-solids problem. Third, sediment frequently damages the area where it comes to rest, for example, lined canals where sediment furnishes a place for aquatic and other weeds to grow.

But it should be noted that erosion and sediment deposition may result in incidental benefits that can be significant and that in certain situations they may be deliberately induced or encouraged, e.g., inducing erosion by lowering the tailwater to increase hydropower head or to maintain the requisite width and depth of navigation or flood control channels or

TABLE 1.--Land utilization and ownership in the United States[1]

Ownership	Major use				
	Cropland[2]	Grassland, pasture, and range[3]	Forest[4]	Special uses and other land[5]	Total
	(millions of acres)				
Federal--------	0.4	157.7	282.0	325.6	765.7
Other public---	2.4	39.4	37.4	43.1	122.3
Indian---------	2.6	32.5	12.9	2.4	50.4
Private--------	438.8	410.8	429.6	48.7	1,327.9
Total--------	444.2	640.4	761.9	419.8	2,266.3

[1]U. S. Department of Agriculture, based on U. S. Census of 1964 adjusted upward about 2 percent to compensate for underenumeration.

[2]Cropland harvested, crop failures, cultivated summer fallow, soil improvement crops, cover crops, idle cropland, and cropland used for pasture.

[3]Open permanent pasture and range and Federal grassland range, all used for grazing.

[4]Includes reserve forest in parks and other special uses and 71 million acres of Federal forest and woodland used for grazing.

[5]Includes 143 million acres in urban and town areas, highways, railroad rights-of-way, airports, flood control areas, and other special use areas, and 277 million acres of marsh, open swamp, bare rock, desert, and tundra.

inducing precipitation of sediments to create new land or to provide an additional buffer zone to protect levees or other riverbank structures.

Flood-borne sediment deposited on productive flood plains may damage crops and, if coarse-textured, reduce the productivity of alluvial soils. Sediment deposits in stream channels reduce their capacity to convey water and sometimes seriously impair drainage of adjacent lands. Drainage and irrigation ditches clogged with sediment do not function, and sediment removal is a costly item of maintenance.

Storage capacity of artificial reservoirs in the country is being reduced at the rate of about 1 million acre-feet each year by the deposition of sediment. This damage is reflected not only in the loss of storage

capacity for water supply, flood control, power generation, navigation and regulation of streamflow for water-quality control, but also in its impact on these facilities for recreation.

But benefits derived from using reservoirs as catchment and retention basins for sediments are substantial at times and may compensate in some degree for the detrimental effects of sedimentation on reservoir purposes and beneficial outputs. Reservoirs provide immediate and effective sediment traps as soon as they are in operation. However, releases of clear water from a newly constructed dam and reservoir may cause severe degradation of the river channel unless the afterbay is properly designed and the stream channel is stabilized at proper grade to control streamflow velocity.

Wearing or abrasion of power turbines, pumping equipment, irrigation-distribution systems, and other structures is accelerated by sediment in the water.

Suspended sediment in water used to recharge underground aquifers artificially clogs the aquifer pore spaces; expenditures for clearing the water are required before it can be used for this purpose.

Tests have established that salts and nutrients, particularly phosphorus, adsorbed on sediment particles dissolve in water and contribute to eutrophication of surface waters and lakes. The oxidation of organic pollutants is hindered by sediment in streams. Pesticide residues may be carried by sediment and may be released in the stream environment to be taken up by various aquatic organisms.

Commercial fisheries, particularly those for shellfish, and the habitat of game fish are damaged by water-borne and water-deposited sediment.

People want clear water for swimming, boating, and fishing. The deposition of sediment on bathing beaches detracts from the esthetics and the enjoyment of these facilities. Both visitor days and fish catch at some formerly clear reservoirs have been reduced significantly because of increasing turbidity due to sediment flow.

The impact of fluvial sediment on the national economy and on the quality of our environment is of tremendous significance. Sediment damage, because of the many ramifications of the problem, has been estimated at more than 500 million dollars annually. In addition, capital investments in treatment facilities are required for processing sediment-laden waters to make them suitable for municipal and industrial uses. Also the value of soil resources lost by erosion is no doubt several times greater than the combined sediment damages.

Because of the tremendous area, agricultural land supplies the greatest amount of sediment to the total load carried by streams. Numerous measurements on plots on which conservation measures have not been used have shown losses from land in continuous row crops ranging from 10,000 to 70,000 tons per square mile per year, depending on soil characteristics, crops, tillage practices, and topographic and climatic factors.

Erosion along rural roads is extremely serious where protection has not been provided. It has been shown that during road construction in Scott Run Watershed, Fairfax County, Virginia, sediment equivalent to some 89,000 tons per square mile per year was produced at the source. About one-half of this amount was measured downstream at a gaging station. The sediment yield for an average storm from highway construction areas was found to be about 10 times greater than that from cultivated land, 200 times greater than that from grassed areas, and 2,000 times greater than that from forested areas. Diseker and Richardson measured erosion losses from bare roadside cuts near Cartersville, Georgia. Amounts equivalent to 27,000 to 185,000 tons of soil were lost per square mile per year depending on the rainfall, the degree of slope and the exposure of the bank. Comparable rates were measured on 35 road cuts in the Baltimore area. Most of the erosion resulting from the logging of forested areas comes from the required roads and their construction. Improperly constructed logging and mining roads on public and private forestland constitute an increasing source of serious sedimentation. Volumes as much as 2,000 cubic yards per square mile of access road have been measured in mountainous country.

Construction activities in urbanizing areas also increase sediment production although rates vary tremendously, depending on size of the drainage areas. On a small construction site at Johns Hopkins University encompassing about $1\frac{1}{2}$ acres, a sediment loss of 328 tons was measured. To illustrate the high sediment yield from areas undergoing construction, sites near Lake Barcroft, Virginia, and Greenbelt, Maryland, produced amounts equivalent to 25,000 and 10,000 tons per square mile annually.

Studies made in southeastern Kentucky indicated that sediment yield from strip-mined coal land can be as much as 1,000 times that from forested areas. In a 4-year period the average annual sediment yield from Kentucky spoil banks was 27,000 tons per square mile while it was estimated to be only 25 tons per square mile from adjacent forested areas.

Erosion is a serious problem on at least 300,000 miles of streambank according to estimates made from actual surveys. Because the banks of the streams and rivers are a part of the water and sediment-conveyance system, material eroded from these banks is immediately available as damaging sediment. Recent surveys of the intermontane region of western United States indicate that 66 to 90 percent of the sediment load in many of the streams comes from streambank and streambed erosion.

The importance of the several sources of sediment and how they may vary in different parts of the country is expressed by the following two examples:

The sources of the sediment yield now experienced in the Middle Fork Eel River in the California Water Resource Region are (a) watershed slopes, 13.5 percent; (b) landslides, 22.5 percent; (c) streambanks, 63.0 percent; and (d) major roads, 1.0 percent.

Of interest is the breakdown of the 13.5 percent arising from the watershed slopes--(a) natural causes, 42.7 percent; (b) logging, 7.7 percent; (c) burns, 3.2 percent; (d) grazing, 24.6 percent; (e) deer, 19.5 percent (as the result of browsing and hindrance to reproduction of vegetation); and (f) temporary logging roads, 2.3 percent.

The Potomac River Basin in the North Atlantic Water Resource Region discharges about 2.5 million tons of sediment to the Potomac estuary each year. Although agricultural lands of this basin produce the major part of the sediment, the urban areas in and around metropolitan areas of Washington, where disturbance of the land surface by construction is active, produces an exceedingly large share of the sediments. Surface mining, highway construction, and now unprotected roadbanks and fills in the Basin also contribute disproportionately large amounts of the sediment if considered in terms of unit area.

It is often not practical to provide sediment control through watershed management to drainage basins in desert areas of the Southwest. In such areas it is usually more feasible to provide sediment control through river management programs that include stabilized stream channels of constant gradient, coupled with specific sediment traps.

Although the erosion processes producing sediment are similar in all parts of the country, the preceding examples indicate that the relative importance of critical sediment source areas varies widely. The contributions from each source must be evaluated in order to recommend and effect control. The quoted examples are mainly in terms of land use, but in selecting and establishing sediment control measures, consideration must also be given to climatic factors, geology, soils, topography, stream channel characteristics, and runoff and streamflow regimes.

Under some circumstances, the cost of erosion control measures is so prohibitive that they are not justified. For example, in desert areas the prevention or control of sediment transport during flash floods or by wind usually is not feasible.

II. Methods and Effects of Control

Stabilization of the sediment source by proper land management and erosion control measures is the most direct and usually the most satisfactory approach in dealing with most sediment problems. Such erosion control practices conserve land and vegetation resources and at the same time reduce sediment yield. Where the sediment is derived from sheet and rill erosion on agricultural, forest, or range lands, certain agronomic and forest and range management practices as well as mechanical and structural measures effectively reduce sediment yields. For instance, changing cultivated fields from row crops to small grain may reduce the soil loss due to sheet erosion 60 to 90 percent, depending on cover conditions, soils, and seasonal distribution of rainfall.

Rotating crops to include meadow in the cropping sequence may reduce the soil loss from fields 75 percent. Such practices as mulching, strip-cropping, and contour cultivation have been shown to be highly effective in reducing soil erosion on farmland. Graded cropland terraces may reduce erosion on fields 75 percent and in combination with crop rotations, mulching, minimum tillage, etc., can further reduce soil loss from cultivated fields.

Converting cropland to good grassland, pasture, or woodland can reduce soil erosion 90 percent or more.

Control of excessive sediment arising from construction activities, including both new highways and industrial and urban developments, could include one or a combination of the following basic approaches: (a) reducing the period of time during which the ground is exposed to erosion and (b) preventing the sediment from making its way to stream courses in the area. The first approach would include such methods as mulching and immediate seeding to grasses or other vegetative cover, sodding, paving, and constructing water collection and disposal systems. Debris basins for trapping and impounding sediment and channels for diverting or spreading surface runoff are effective means of keeping sediment from watercourses.

The treatment of existing unprotected surface-mined land to control erosion can be accomplished by basic reclamation of these lands. This basic treatment would consist of applying corrective measures, both vegetative and structural. The methods employed should not only reduce erosion on the exposed areas and alleviate the sediment pollution problem of the streams but should also be designed to alleviate the concurrent acid mine drainage problem, which is a directly related pollution problem.

The control of streambank and streambed erosion usually requires emphasis on structural measures. Grade stabilization structures, riprap on streambanks, installing jacks to induce deposition, and sloping and vegetating eroding banks are among the measures to be considered.

There is ample evidence to support using such structures to reduce sediment yields. Agronomic and supporting mechanical field practices have reduced the amount of sediment reaching reservoirs by amounts ranging from 28 to 73 percent. Good conservation practices on cultivated watersheds have reduced sediment yields almost 90 percent. The protection of existing forest and range lands by these measures has reduced sediment yields as much as 90 percent. Streambank-protection work on Buffalo Creek, New York, reduced sediment delivery to Buffalo Harbor during flood flows 40 percent. It is anticipated that the sediment yield from logging operations in the Middle Fork Eel River, California, will be reduced about 80 percent with proper planning and management.

Benefits accrue from the control of sediment pollution in many ways. They include (1) reduction in the cost of removing sediment from channels, harbors, and reservoirs; (2) reduction in the cost of treating water for municipal and industrial uses; (3) reductions in maintenance costs associated with power production, water distribution systems, and highways; (4) reductions in damage to wildlife habitat; (5) prevention of damage to flood plains; and (6) enhancement of recreational facilities. Corollary to the reduction of damage caused by sediment, effective control maintains the productivity of the soil resource and prevents the loss of land.

III. Areas of Emphasis

The Federal programs for erosion and sedimentation research, including the cost thereof, are under continuing review, together with other aspects of water resources research, by the Committee on Water Resources Research (COWRR) of the Federal Council for Science and Technology. This committee has developed and is updating long-range programs for research in this area. A work group assigned to substantive review of efforts, plans, and goals for research in the general field of surface water hydrology (SURHY Work Group), in reporting to COWRR in June 1967, confirmed the need for increased emphasis on erosion and sedimentation research and presented detailed recommendations that should be consulted but that are beyond the scope of this report.

The following areas should receive principal emphasis. Research to develop new and improved technology essential to program effectiveness must be considered in connection with each action program.

1. Minimizing soil erosion and curbing sediment delivery from agricultural, range, and forest lands

Existing legislation authorizes the Department of Agriculture to provide technical assistance to farmers, ranchers, and other private landowners to achieve erosion control and also to provide forest management and fire control programs. Existing legislation also authorizes cost-sharing (principally on an annual basis through the Agricultural Conservation Program) and payments for diversion of cropland acreage to conserving uses of the land.

Contractual arrangements are authorized under several USDA programs, including the Great Plains Conservation Program, the Appalachian Land Stabilization and Conservation Program, the Cropland Conversion Program, and the Cropland Adjustment Program, to achieve erosion control and other conservation benefits. The Department of Agriculture anticipates proposing similar arrangements under the Soil Conservation and Domestic Allotment Act as amended. Existing and proposed legislation constitute a satisfactory basis for working with owners and operators of private lands in establishing those erosion control measures that can be justified on the basis of returns to the owners and operators.

Existing loan programs within USDA make funds available to individuals and associations to aid in the establishment of soil and water conservation practices. With additional funds, these programs could be expanded.

Existing legislation for effective erosion control on public lands as well as on Indian lands is generally adequate. The lack of adequate programs in erosion control on these lands stems from the need for increased funding to conduct needed programs.

It must be recognized, however, that many critical sediment source areas, on both privately owned lands and certain public lands, such as landslides, badly eroding logging roads and hillsides, and deep gullies, are not treated because onsite benefits are insufficient to justify costs. Most of such critical source areas should be stabilized or brought under control to reduce sedimentation that may adversely affect downstream water users. Numerous offsite benefits derive from such work--reduction of sediment damage to lands both adjacent and far removed and to the aquatic habitat; preservation of stream-channel flow capacity and reservoir storage capacity; reduction in turbidity and in pollution of water in streams and lakes; maintenance of attractive water-based recreation opportunity. Under existing legislative authority the necessary work is not possible for every situation requiring it. Additional legislation or funds, or both, are required to cover the cost of such measures over and above the amounts that can be justified on the basis of onsite returns.

2. Controlling sediment in stream channel systems

Unlike the treatment of many erosion problems that can be done by individual landowners, the control of streambank erosion requires consideration of an entire stream or major reach involving many landowners and communities. The vegetative and structural measures that have been developed have wide application in solving stream erosion problems. Adequate legislative authority or funding, or both, are needed to attack the problem on an estimated 300,000 miles of streambank.

Channel erosion within the rangeland watersheds of public and Indian lands can be controlled to a substantial degree through watershed treatment. The authority to conduct the programs needed on these lands is considered adequate but the rates of investment must be accelerated to accomplish them.

The USDA Agricultural Conservation Program includes a streambank-stabilization practice for which cost-sharing assistance for voluntary performance would be available to most farms and ranches (including Indian lands and farms owned by State or local governments), either by individual farms or through multiple-farm pooling agreements. Assistance is not available under this program to a nonfarmer and usually not for federally owned land. Nor is it available to an organization such as drainage districts, etc., which are essential for equitable financing and required maintenance, that assesses landowners for these purposes, collects taxes (or if uncollected establishes a lien against the land), and pays for the work with these funds.

Soil and moisture conservation funds are available to a number of Federal agencies to prevent erosion of Government-owned lands and to control eroding streambanks that endanger Federal property. Additionally, the Department of the Interior performs certain streambank stabilization and related sediment control work under specific authorizations of Congress.

Limited amounts of streambank stabilization work can be done under provisions of the USDA-administered Watershed Protection and Flood Prevention Act, PL-566, which requires that the entire watershed of a stream be brought into the plan.

Department of Defense projects[1], designed for other purposes, contribute significant incidental benefits in preventing or controlling sediments already being transported by streams or in reducing erosion of riverbanks and riverbeds. Thus, Department of Defense and Department of the Interior reservoirs for flood control, hydropower, recreation, and other purposes also serve as highly effective sediment traps and, by controlling and reducing peak flows, also reduce stream erosion and sediment transport. In some upstream reservoirs, incremental storage capacity is provided beyond that required for the effective operation of those reservoirs over their designed economic or technological life, as a means of reducing sedimentation of downstream reservoirs, locks and dams, or channels. Along certain reaches of the Mississippi, Missouri, Arkansas, Red, Sacramento, Willamette, and other rivers, bank stabilization is an integral component of specifically authorized Department of Defense flood control or navigation projects or project-systems and is provided as a means of stabilizing channel dimensions and alinements or to protect levees and floodwalls.

Under its "Emergency Bank Protection" program authorized by Section 14 of the 1946 Flood Control Act, the Department of Defense constructs works to protect endangered highways, highway bridge approaches, and other essential or important public works, such as municipal water supply systems and sewage disposal plants, which are threatened by flood-caused bank erosion. A Section 14 project must be complete in itself and must not require additional work for effective operation. Each project must be economically justified, and the maximum Federal expenditure per project is $50,000. The local sponsoring agency must agree to provide, without cost to the United States, all lands, easements, and rights-of-way, and all required alterations and relocations of utility facilities; to hold and save the United States free from damages; to maintain the project after completion; to assume all project costs in excess of the Federal cost limit of $50,000; and to provide a cash contribution in proportion to any special benefits to nonpublic property.

[1]Refers to Civil Works Program of the Corps of Engineers.

In accordance with Section 120 of the River and Harbor Act of 1968, the Corps of Engineers is conducting a study of the nature and scope of damages resulting from streambank erosion throughout the United States, with a view toward determining the need for and the feasibility of a coordinated program of streambank protection, in the interest of reducing damages from the deposition of sediment in reservoirs and waterways, the destruction of channels and adjacent lands, and other adverse effects of streambank erosion. The report on this study is to include recommendations on an appropriate division of responsibility between Federal and non-Federal interests.

Executive Order 11288 of July 2, 1966, provides for broad responsibilities and authorities in every phase of water-quality management. This authority extends to the activity regardless of the form of improvement, i.e., sediment. The heads of agencies are held responsible for sediment pollution caused by all operations of the Federal Government, such as water-resource projects and operations under Federal loans, grants, or contracts.

Under the Water Quality Act of 1965 and the Clean Water Restoration Act of 1966, the Department of the Interior has responsibility for..."developing and demonstrating...: Practicable means of treating...waterborne wastes to remove physical, chemical, and biological pollutants in order to restore and maintain the maximum amount of the Nation's water at a quality suitable for repeated use." Abatement of pollution is implemented through grants and contracts to individuals, industries, local communities, municipalities, etc., in which a particular project may receive support of as much as 75 percent of the total investment.

3. Controlling sediment from erosion along rural roads under local control and in connection with all highway and road construction programs

The Department of Transportation gives national leadership to the erosion control program on 875,000 miles in the Federal-aid highway system. This consists primarily of the inter-State system and other major arteries and is about one-fourth of the 3.7 million miles of roads in the United States. Municipalities are responsible for the erosion problem on the 500,000 miles of streets and roads under their jurisdiction. This leaves about 2.3 million miles of State and county secondary roads, of which about 20 percent, roughly estimated, require more complete erosion control measures.

Existing programs provide only a small fraction of the rural roads and highways with an adequate erosion control program.

There are about 200,000 miles of roads on public lands administered by several Federal agencies. These agencies, under existing authorities, are responsible for the control of erosion and sediment along these roads. The Department of Agriculture, through the P.L. 566 watershed program, provides some limited cost sharing for treating high-sediment source areas on secondary roads within the confines of approved watershed projects. But these treated areas are only a small part of the area needing treatment.

In a recent survey in 34 States, USDA concluded that roughly 470,000 miles of rural highways and roads require treatment. Of this amount, 400,000 miles cannot receive attention because current methods of funding and support are inadequate.

The estimated costs of roadside erosion control range from $275 per mile where control can be achieved by vegetative programs to $15,000 per mile where combinations of sloping, vegetating earth cuts and fills, vegetating or lining waterways and channels, diversions, retarding structures, surface and subsurface drainage, and special erosion control structures are necessary. The Department of Agriculture estimates the weighted cost of treatment at approximately $2,300 per mile. The problems of control on existing highways are often difficult because the opportunity to change location or design is extremely limited.

4. Controlling sediment derived from erosion of abandoned surface mines within the context of mine-waste control

Surface and strip mining operations have exposed 1,900,000 acres of land to acid mine drainage and sediment pollution. These acres are reclaimable.

It is estimated that in the United States mine drainage contributes the equivalent of more than 4 million tons of sulfuric acid per year to about 11,000 miles of streams and other receiving waters.

Since mining at or near the surface has been a practice in this country for more than a hundred years, most of the areas needing reclamation were mined before passage of State laws pertaining to protection of lands and stabilization of the sources of acid mine drainage and sediment in mined areas. This accounts, in part, for the fact that most of the areas damaged by surface mining are now orphaned lands, i.e., no one is obliged to restore or reclaim them. Additional programs are needed if we are to reclaim these abandoned areas.

To insure that this situation does not continue, thirteen States have passed laws regulating future surface mining. The President has

proposed the Surface Mining Reclamation Act to provide for Federal-State cooperation to insure that all lands disturbed by surface mining in the future will be reclaimed. This program would be administered by the Department of the Interior. This authorizes the expenditure of funds "...for the purpose of reclaiming, improving, grading, or seeding or reforestation of strip-mined areas...on lands owned by Federal, State, or local bodies of government..."

A major mine problem--acid mine drainage--is caused by exposure of pyritic materials to air and water, both during the mining process and after the mine has been abandoned. There is a wide range of available techniques to be used in an assault on the problem, including treatment of effluent water as well as source control. These are neutralization, distillation, reverse osmosis, ion exchange, freezing, and electrodialysis techniques. Source control includes water diversion, mine sealing, surface restoration, and revegetation. The latter two approaches are those most specifically associated with sediment control. Whereas the effectiveness of source control techniques seldom exceeds 75 percent, the effectiveness of the various effluent-treatment processes ranges from 90 to 99 percent. Extensive current information indicates that a program for surface restoration and revegetation should be based on preventing erosion and intercepting or reducing surface runoff to prevent aggravation of the acid mine drainage problem.

Current programs to reclaim surface-mined lands are few, and they are not closely related. The only one specifically oriented to this objective is Section 205 of the Appalachian Regional Development Act.

Since public lands are only a small part of the total area mined in Appalachia, this Section does not give adequate assistance to the reclamation and utilization of privately owned, orphaned, mined lands, which are now largely public liabilities.

There are other programs that are related in their conservation objectives or that contribute in a limited way to meeting the surface-mine reclamation problem. For example, the Soil Conservation and Domestic Allotment Act (as amended) and the Watershed Protection and Flood Prevention Act (as amended) can be, and already have been, useful instruments for the Department of Agriculture in working with private landowners on such problems. Also the Agricultural Conservation Program can provide cost-sharing assistance for farmers on surface-mined farmland.

Much of the contribution by the Federal Government toward reclamation of surface-mined land has been through research. The Department of Agriculture has developed methods for conducting inventories of mined lands, classifying mined areas as sources of sedimentation, and establishing vegetative cover on disturbed land.

Since passage of the Water Quality Act of 1965 and the Clean Water Restoration Act of 1966, the Department of the Interior has had an active program to demonstrate methods and systems to abate pollution from mined areas, which includes in-house projects, grants and contracts for land reclamation, reforestation, and sediment control as well as various treatment techniques.

The Clean Water Restoration Act of 1966 authorizes the Department of the Interior to control or abate water pollution resulting from industrial and other activities. Under this legislation, the Department has an active program in acid mine drainage control.

5. Assisting local governments in effective erosion and sedimentation control in urban and industrial developments

Industrial and urban development give rise on a unit-area basis to a disproportionate share of sediment. Knowledge of technical and detailed conservation needs and experienced personnel can guide local organizations to solve these community problems. An example is the sediment-control program used in Montgomery County, Maryland. Fairfax County, Virginia, has stringent requirements for a conservation plan and the posting of bond before development of land by industrial and urban interests. Such means of controlling these sediment sources should be encouraged, with local organizations developing and maintaining the authorities and regulations.

The Department of the Interior program for control and treatment of pollution from storm and combined sewer systems includes methods to abate pollution from urban runoff.

Additional assistance is needed by local governments in effecting such sediment control through additional financial and technical assistance and aid in the formulation of model regulations.

SEDIMENT

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from sediment. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

DOD data for action programs under existing legislation in the table on sediment in stream channel systems represent totals based on the following figures:

Activity	Current		Projected (year of funding)					
	1968	1969	1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	5-yr. total
				(Million dollars)				
Reservoirs..	38.55	48.55	47.97	49.49	51.72	54.45	54.48	258.11
Bank stabilization.....	64.27	56.95	62.40	64.33	70.63	70.65	74.75	342.75
Dredging....	81.00	81.00	85.00	89.00	93.00	97.00	102.00	466.00
Data collection.....	.30	.30	.30	.30	.30	.30	.30	1.50
Total ..	184.12	186.80	195.67	203.12	215.65	222.40	231.53	1,068.37

Minimizing soil erosion and curbing sediment delivery from agricultural, range, and forest lands

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	2.73	2.78	3.32	3.93	4.31	4.79	5.25	21.60
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	.62	.62	.70	.70				3.10
Action								
USDA	260.95	262.15	295.23	329.53	364.23	401.03	441.13	1,831.15
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-		-	-	-
USDI	21.20	29.60	22.00	30.50				199.00
Loan Level								
USDA	9.00	7.00	66.00	95.00	95.00	95.00	95.00	446.00
Proposed Legislation								
Research and Development								
Action								
USDA	-	-	10.00	10.00	10.00	10.00	10.00	50.00
USDI	-	-	-	-	-	-	-	-
Loan Level								
USDA	-	-	-	-	-	-	-	-

Controlling sediment in stream channel systems

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.64	.65	.82	1.23	1.33	1.48	1.61	6.47
DOD	.15	.15	.15	.20	.25	.25	.15	1.00
DHEW	-	-	-	-	-	-	-	-
USDI	.57	.59	.65	.75				4.75
Action								
USDA	15.98	15.48	14.68	16.08	17.58	18.98	20.98	88.30
DOD 1/	184.12	186.80	195.67	203.12	215.65	222.40	231.53	1,068.37
DHEW	-	-	-	-	-	-	-	-
USDI	7.60	8.00	8.70	10.70				53.90
Loan Level								
USDA	-	-	-	-	-	-	-	-
Proposed Legislation 2/								
Research and Development								
Action								
USDA	-	-	4.00	6.00	8.00	10.00	12.00	40.00
USDI	-	-	-	-	-	-	-	-
Loan Level								
USDA	-	-	-	-	-	-	-	-

1/ It does not appear feasible to separate costs associated solely with sedimentation control. (Please see front page of sediment funding tables.)

2/ The total costs and desirable scheduling of a coordinated program of streambank control, which may be recommended to Congress for authorization as a result of the current Corps of Engineers nationwide study of this problem, are presently unknown.

Controlling sediment from erosion along rural roads under local control and in connection with all highway and road construction programs

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.30	.31	.42	.51	.56	.62	.67	2.78
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	8.50	6.90	7.60	9.10	9.70	10.20	10.50	47.10
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	.30	.40	.30	.40	.50	.60	.70	2.50
Loan Level								
USDA	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
Action								
USDA	-	-	8.00	10.00	12.00	14.00	16.00	60.00
USDI	-	-	-	-	-	-	-	-
Loan Level								
USDA	-	-	-	-	-	-	-	-

Controlling sediment derived from erosion of abandoned surface mines within the context of mine-waste control

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.26	.28	.38	.45	.50	.55	.50	2.47
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	.60	.60	1.00	1.40	1.60	1.90	2.30	8.20
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI 1/ & 2/	1.83	3.60	2.90	4.30	5.80	7.20	6.30	26.50
Loan Level								
USDA	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
Action								
USDA	-	-	17.70	20.10	23.60	23.60	23.60	108.60
USDI 1/ & 2/	-	-	3.20	4.20	6.70	17.50	32.50	64.10
Loan Level								
USDA	-	-	-	-	-	-	-	-

1/ & 2/ For repair of past damage to surface and underground mine structures. The parts of the respective programs dealing with sediment control cannot be separated from the total program. Figures do not include the projected costs of administering the proposed Surface Mine Reclamation Act.

Assisting local governments in effective erosion and sedimentation control in urban and industrial developments

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	-	-	-	.03	.07	.10	.13	0.33
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	.05	.05	.05	.05	.05	.05	.05	0.25
Action								
USDA	3.94	4.14	5.64	6.64	7.14	7.14	7.14	33.70
DOD	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI 1/	10.00	10.00	10.80	15.30	20.30	16.50	16.50	79.40
Loan Level								
USDA	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
Action								
USDA	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Loan Level								
USDA	-	-	-	-	-	-	-	-

1/ The parts of the respective programs dealing with sediment control cannot be separated from the total program.

Department and Legislation	rosion and sedimentation control d industrial developments				Total					
	Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
USDA										
Existing	4.14	33.30	--	--	4.02	33.65	289.27	2008.05	7.00	446.00
Proposed	--	--	--	--	--	--	--	258.60	--	--
DOD										
Existing	--	--	--	--	.15	1.00	186.80	1068.37	--	--
Proposed	--	--	--	--	--	--	--	--	--	--
USDI										
Existing	10.00	79.40	--	--	1.26	8.10	51.60	361.30	--	--
Proposed	--	--	--	--	--	--	--	64.10	--	--
TOTAL										
Existing	14.14	112.70	--	--	5.43	42.75	527.67	3437.72	7.00	446.00
Proposed	--	--	--	--	--	--	--	322.70	--	--

1/ See tables fo

Areas of Emphasis--Estimated Funding 1/

Department and Legislation	Soil erosion and sediment delivery from agricultural, range, and forest lands						Sediment in stream channel systems						Sediment from erosion along rural roads and in connection with highway and road construction						Sediment from erosion of abandoned surface mines						Effective erosion and sedimentation control in urban and industrial developments						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																																			
USDA																																				
Existing	2.78	21.60	262.15	1831.15	7.00	446.00	.65	6.47	15.48	88.30	--	--	.31	2.78	6.90	47.10	--	--	.28	2.47	.60	8.20	--	--	--	.33	4.14	33.30	--	--	4.02	33.65	289.27	2008.05	7.00	446.00
Proposed	--	--	--	50.00	--	--	--	--	---	40.00	--	--	--	--	--	60.00	--	--	--	--	--	108.60	--	--	--	--	--	--	--	--	--	--	--	258.60	--	--
DOD																																				
Existing	--	--	--	--	--	--	.15	1.00	186.80	1068.37	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.15	1.00	186.80	1068.37	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																																				
Existing	.62	3.10	29.60	199.00	--	--	.59	4.75	8.00	53.90	--	--	--	--	.40	2.50	--	--	--	--	3.60	26.50	--	--	.05	.25	10.00	79.40	--	--	1.26	8.10	51.60	361.30	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	64.10	--	--	--	--	--	--	--	--	--	--	--	64.10	--	--
TOTAL																																				
Existing	3.40	24.70	291.75	2030.15	7.00	446.00	1.39	12.22	210.28	1210.57	--	--	.31	2.78	7.30	49.60	--	--	.28	2.47	4.20	34.70	--	--	.05	.58	14.14	112.70	--	--	5.43	42.75	527.67	3437.72	7.00	446.00
Proposed	--	--	--	50.00	--	--	--	--	--	40.00	--	--	--	--	--	60.00	--	--	--	--	--	172.70	--	--	--	--	--	--	--	--	--	--	--	322.70	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

ANIMAL WASTES

I. The Problem

Animal wastes in this country probably exceed wastes from any other segment of our agricultural-industrial-commercial-domestic complex. Approximately 1.7 billion tons of animal wastes are produced annually, one-third of which is liquid. Used bedding, litter, paunch manure, and dead animals and birds add significantly to the problem. As much as 50 percent of this waste can come from concentrated production systems.

The trend in livestock, milk, poultry, and egg production is toward automation and centralization. Consequently, animal wastes tend to be more concentrated at point locations than in the past when they were distributed widely in the rural areas.

The expansion of urban and suburban developments into former agricultural areas and the concentration of animal production have accentuated health and pollution problems associated with livestock and poultry production and with conventional methods of manure disposal on the land.

A large number of beef cattle receive their final feeding, growth, and fattening in large and centralized feedlots. A beef animal may spend the final 3 to 5 months of its life under concentrated and confined feeding conditions. This concentrated feeding provides for more and better beef, but it also results in greater concentrations of waste.

Single feedlots may contain more than 10,000 cattle. An accumulation of several inches of manure in the feedlot is not unusual. Under these conditions fly breeding, odors, and manure dust also become problems. Runoff and leaching created by cleaning operations and rainfall may result in stream and ground-water pollution.

The trend toward confinement production is also firmly established in the swine, poultry, and dairy industries. Units marketing 300 to 1,500 hogs per year are not uncommon and further expansion can be anticipated. The number of poultry handled in a single operation often exceeds 20,000 and the waste produced can exceed 5 tons daily. In modern mechanized dairies, milk-cow populations of 50 to 200 are common. Rapid strides have been made in developing efficient housing, exercise, and feeding and milking areas. But waste handling remains a major problem.

Although the concentration of animals in fewer and larger operations offers size advantages for economy of operation, the problem of waste management is increased. Our technology must be improved and applied to collect, handle, treat, reclaim, or ultimately dispose of the increasing volume of wastes.

Economic studies indicate that the high cost of handling manure has reduced its competitive position as a fertilizer. Feedlot operators who formerly realized some profit from sale of manure now pay to have it trucked away.

Water pollution aspects

The biochemical oxygen demand (BOD) of animal manure is extremely high. It is also high in the runoff from feedlots and in effluent from treated wastes. The BOD of grab samples from manure-holding tanks and pits may be 100 times that of municipal sewage; the BOD of runoff from feedlots, 10 to 100 times; and the BOD of treated waste effluent, 10 times. Such high oxygen-demanding wastes entering streams cause oxygen depletion and can result in serious fish kills and long-term ecological imbalances. They also can affect the esthetic value of streambanks and render them unattractive as recreational areas.

Excessive concentrations of nitrates in ground water used for drinking may be biologically converted to nitrites in the digestive system and can cause methemoglobinemia (blue babies). They are also toxic to livestock. Animal manure is a source of nitrates, and the importance of its contribution must be considered.

Another facet of the animal-waste problem shows up in accelerated eutrophication of lakes and ponds and overfertilization of streams. Nutrients in runoff from feedlots and other animal-manure sources are of concern. Nitrogen and phosphorus are the principal elements involved, but "triggering" plant nutrients are also important. It has been postulated that trace elements or vitamins also trigger eutrophication.

Organisms pathogenic to people, animals, and poultry may be present in the excreta of wild and domestic animals. Some infectious agents may also be present that are harmful to plants. These agents may be transported in our surface and subsurface water. Consideration must be given to the control of movement of these organisms.

Air pollution aspects

One of the major problems with respect to animal wastes and air pollution is odor control. This problem is accentuated by the encroachment of urban development into the rural setting and the narrowing of the buffer zones between densely populated areas (or resort areas) and agricultural enterprises. On both the east and west coasts, numerous concentrated egg, swine, and dairy production enterprises have been forced to cease operation or to relocate because odors and other nuisances were objectionable to their metropolitan neighbors. The New York-New Jersey and the Los Angeles metropolitan areas are prime examples of this problem.

Within the last 6 years, 43 dairy operations have had to move out of Los Angeles County. In the Midwest, damage suits have been brought against a number of large feedlots because of odors, dust, and flies.

The possible transmission of human, animal, and plant infectious agents associated with animal-manure dust must also be mentioned. This problem may be more potential than real, but much more needs to be known about it.

Soil pollution aspects

The problems of soil pollution associated with animal wastes are similar in type if not in degree to the problems of air and water pollution. Soil receiving animal wastes may become contaminated with organisms affecting humans, animals, or plants. Manure-borne weed seeds may be distributed widely over the land. Chemicals in animal wastes may contribute to localized soil problems. The excess organic materials from heavy applications of animal wastes are harmful to some crops and soils. The nutrients in the wastes may create an undesirable imbalance of nutrients for some crops.

Insect pests and vectors

The importance of animal wastes in the reproduction of insect pests and vectors of many diseases is well documented. Studies in California have indicated that feedlots are one of the foremost sources of flies today. Control of insect pests or vectors involves frequent removal of manure from animal quarters and its rapid treatment and disposal. Thus the problem is one of developing more efficient methods of waste handling.

II. Methods and Effects of Control

There are many possibilities for improved management and reclamation of animal wastes. Treatment and handling methods must be developed to conform with the various water- and air-quality standards developed by the States and by the Federal Government.

Spreading manure on the land to reclaim nutrients is not now economically competitive with the application of mineral fertilizers. Three control approaches can be taken to minimize pollution from animal-feeding operations--

(1) Increasing utilization and application of existing technology

(2) Enforcing regulations where improvement is technically feasible

(3) Developing more effective, complete, and economically feasible waste-management systems

The Department of Agriculture has developed information on specific animal-waste handling processes. Much of this information has been applied on a limited basis and is potentially adaptable to wider use. The Department of Health, Education, and Welfare and the Department of the Interior also are studying animal-waste management. For example, the Department of the Interior is demonstrating the application of existing treatment and management techniques in both farm and concentrated feeding operations.

Industry also has developed information on specific waste handling techniques that are adaptable to animal-waste management. In addition, modified techniques from associated programs in municipal and industrial waste treatment should be adaptable to the liquid wastes from concentrated animal-feeding operations, for example, the activated sludge processes, chemical treatment for phosphate removal, and denitrification. Also, the numerous methods for handling and transporting domestic sludge and low water-content sewage can be modified.

Under the Water Quality Act of 1965, each State is obligated to develop standards for the quality of receiving waters. All the States have developed these water-quality standards and the Department of the Interior has accepted almost all of them. Under both Federal and State standards, enforcement of effluent and receiving-water quality is handled primarily by the States with the Department of the Interior providing additional enforcement resources when required.

Efforts must be intensified to insure compliance with existing zoning regulations and to introduce more stringent zoning requirements to provide buffer zones around urban areas. These actions must be designed to protect both the public and the animal industry.

Animal-waste management must be integrated and coordinated with the total national pollution abatement plan. The importance of pollution control in the total management concept of the animal-feeding industry must be recognized now and integrated into planning and operations. Long-range control demands more effective, complete, and economic waste management to meet pollution problems of the future. Intensified research and development is needed in all phases of animal-waste management, including characteristics of manures, removal from animal quarters, runoff, storage, transport, treatment, ultimate disposal, and economic evaluation to insure improvement of environmental quality with minimum disruption of current production-efficiency levels.

III. Areas of Emphasis

The following areas encompass the elements of a program for controlling animal wastes.

1. Minimizing pollution by improved use of existing technology as well as by developing new and improved animal-management methods and facility design

The Department of Agriculture is performing research to identify the characteristics of animal wastes and the nature of pollution arising from livestock operations. Research has been initiated, with emphasis on cattle and poultry operations, to develop improved techniques and facility designs to handle and dispose of wastes in a manner that will reduce air and water pollution.

USDA action programs are directed toward (1) educational programs that recommend designs and management techniques that will alleviate pollution through use of current knowledge; (2) technical assistance within soil conservation districts and through extension specialists; and (3) loans to individuals and associations or groups of farmers who need to improve their facilities--improving animal-waste handling facilities would qualify. USDA envisages expansion in all types of activities and considers incentive payments particularly necessary in this area.

The Department of Health, Education, and Welfare is currently collaborating in a study being carried on by the State of New Jersey which includes consideration of the enforcement of criteria directed toward the better application of known technology. It is anticipated that the criteria and standards developed by the study will form the basis for enforceable regulations on a statewide basis.

The primary function of DHEW in this area will be to develop manuals, guides, and criteria for use and application by solid-waste program administrators in dealing with the off-farm problems of animal solid wastes, particularly in those situations where interfaces exist between large feedlots and urban environments. Technical assistance supported by organized training programs will be provided to interested control and health agencies.

The Department of the Interior has research and demonstration programs to develop improved techniques and facility designs to handle animal wastes in a manner that permits discharges that meet existing water-quality standards. In addition, it has a large program of research development and demonstration in the broad area of industrial pollution control and abatement. Under these programs, the Department is investigating various means for modifying the source, quantity, and

quality characteristics and to develop means for prevention, control, and treatment of the animal wastes. USDI feels that existing legislation is adequate but that increased funds are necessary to implement the program.

2. Minimizing pollution by improved use of existing technology as well as by developing new and improved waste treatment and disposal methods

The Department of Agriculture's research program is directed toward methods of treating and disposing of animal wastes through a variety of techniques such as lagoons, oxidation ditches, and application to cropland. Additional research will be performed, including the investigation of other methods of disposal and of the capacity of cropland to accept animal wastes without damage to crops and land.

USDA action programs are generally in the form of educational and technical assistance provided directly to individual or groups of livestock producers in rural communities. Loan assistance for treatment and disposal systems is currently available for groups of farmers or associations. Cooperative and watershed organizations are expected to be utilized in the development of loan, grant, and research participation reimbursement programs for use in developing needed treatment and disposal systems.

The Department of Health, Education, and Welfare is supporting research on new methods of disposal of animal wastes on land, such as injection, composting studies to produce a product that can be disposed of more readily, lagooning, and incineration. While it is not anticipated that economically profitable methods will evolve in the near future, a substantive saving in costs of disposal may be possible.

The results of these and other research and studies will permit DHEW to establish standards of disposal and to set up a technical assistance program to State and local authorities to accelerate application of the standards. It is anticipated that demonstration grants (under the Solid Waste Act) and loan of personnel will be made in support of this program. The Department proposes keying this program to the need of large-scale producers such as feedlot operators and poultry producers.

The primary thrust of the program in the Department of the Interior is to utilize existing technology and develop new or improved treatment and disposal methods. The Department supplies direct technical aid to help resolve the water-pollution problems from feedlot operations and has a program of intramural and extramural research, development and demonstration of numerous unit processes and systems to minimize

pollution from animal-feedlot operations. Section 6 (b) of the Water Quality Restoration Act of 1966 provides for grant support up to 70 percent of total project costs to institutions, industries, and individuals with a maximum support level of $1,000,000. The existing extramural program involves the development and demonstration of improved techniques for controlling and treating liquid wastes from concentrated animal feeding operations. Included in this effort are lagoons, oxidation ditches, chemical treatment, activated sludge, biological denitrification, ultra filtration, and other concepts from the Advanced Waste Treatment program being adapted for application to animal-waste treatment.

3. Minimizing pollution by improved use of existing technology as well as by developing new and improved methods for converting wastes to useful products

The Department of Agriculture has conducted research on techniques and uses of animal wastes for profit or at least on offsetting disposal costs for several years. The conversion of poultry feathers into a protein feed is a classic example. Research for both on-farm and off-farm uses and processes is expected to continue. Action programs in this area of emphasis are primarily in the form of technical assistance in the construction of processing plants. As new developments arise, educational and technical assistance programs will probably be handled with work in other areas of emphasis.

Research in the development of useful products is being supported by the Department of Health, Education, and Welfare. Examples of research include conversion of animal wastes to animal feed, soil conditioners, or fertilizer carriers, and extraction of protein for use as food supplement. The potential for reuse or recycling of these wastes is also studied. As indicated previously, the objective at this point is to effect a reduction in cost of disposal without necessarily realizing a profit. Demonstration grants will constitute the basic support mechanism of DHEW in the translation of the laboratory and pilot plant findings into full-scale operations. A technical assistance program to State and local agencies and private entrepreneurs will be established.

The Department of the Interior, in its efforts to dispose of treatment plant sludges, has as part of some of its projects the conversion of waste material into useful products or energy sources.

4. Minimizing pollution through (a) assisting in the establishment and enforcement of standards, and (b) providing criteria for land use planning

The Department of Agriculture research in this area is currently addressed toward land use planning, as a basis for developing criteria that are realistic in terms of the capability of the producer to meet them and in proper balance with other forms of pollution control. Research is needed to develop sound plans and implementation techniques for accomplishing protective zoning for agricultural production.

USDA action programs are currently very limited; they consist primarily of educational programs to help rural communities and rural areas develop plans and legislation for rural development and planning in which pollution control is one of the considerations. Expansion of this activity as well as a grant program for planning and implementation of standards and rural zoning is considered necessary. USDA has no authority for establishing or enforcing standards in this area.

The Department of Health, Education, and Welfare program is predicated on the fact that the basic responsibility for enforcement actions must reside with the State and, particularly, the local authorities. Support could probably be best developed through the mechanism of program support grants, but such grants are not authorized in the present Solid Waste Act. Eventually, the regulation and enforcement must be assumed by the local authorities as a part of their regularly constituted activities. Efforts in this direction are incorporated as a regular element in the DHEW program in dealing with State and local authorities. Manpower needs would require an expanded cadre of trained personnel. Current training activities of the Solid Waste Program will help to meet this need. The enforcement program must be based on reasonable and adequate criteria and standards which will evolve over the coming year.

The problems of land use planning have been given little consideration as they relate to installations producing animal wastes. Land use planners must be supplied with criteria which if met will permit the location of agricultural production centers in the vicinity of urban areas and the labor supply. The development and use of the appropriate criteria as planned by DHEW would provide the tool for progress and enlist the support and cooperation of the planners.

Water-quality standards adopted by all 50 States and approved by the Secretary of the Interior include plans for implementation for inter-State streams, lakes, and coastal waters. With few exceptions these standards deal effectively with municipal and industrial wastes and their effect on water quality. However, with regard to agricultural

waste in general many difficulties have been encountered in developing appropriate and workable standards. Additional technical information is needed on the characteristics of runoff and on the effectiveness of the numerous treatment concepts being considered to implement the existing standard requirements.

ANIMAL WASTES

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from animal wastes. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

Minimizing pollution by improved use of existing technology as well as by developing new and improved animal-management methods and facility design

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.90	1.20	1.90	2.10	2.30	2.60	2.90	11.80
DHEW	.03	.03	--	--	--	--	--	--
USDI	.02	.06	.11	.11	.11	.12	.13	.58
Action								
USDA	.22	.22	2.46	4.30	5.52	7.22	7.94	27.44
DHEW	--	--	.08	.12	.16	.20	.23	.79
USDI	.08	.15	.50	1.00	1.00	1.00	1.00	4.50
Loan Level								
USDA	2.00	--	100.00	150.00	150.00	150.00	150.00	700.00
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	34.68	49.08	50.13	51.63	54.60	240.12
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	88.20	120.00	120.00	120.00	120.00	568.20

Minimizing pollution by improved use of existing technology as well as by developing new and improved waste treatment and disposal methods

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.10	.20	.50	.50	.60	1.00	1.40	4.00
DHEW	.31	.30	.10	.13	.15	.18	.18	.74
USDI	.18	.25	.40	.75	.75	.75	.75	3.40
Action								
USDA	.27	.25	1.50	1.75	2.10	2.10	2.10	9.55
DHEW	--	--	.51	.80	.97	1.14	1.31	4.73
USDI	.10	.35	1.00	4.00	4.50	5.00	5.00	19.50
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	81.22	114.97	118.17	121.67	128.60	564.63
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	205.80	280.00	280.00	280.00	280.00	1325.80

Minimizing pollution by improved use of existing technology as well as by developing new and improved methods for converting wastes to useful products

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.10	.10	.40	.60	.80	1.00	1.00	3.80
DHEW	.16	.16	.15	.23	.28	.33	.43	1.42
USDI	--	.03	.55	.75	.75	.75	.75	3.55
Action								
USDA	.03	.03	.03	.03	.03	.03	.03	.15
DHEW	--	--	.31	.63	.95	1.47	2.18	5.54
USDI	.03	.08	.20	.50	.75	.75	1.00	3.20
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	1.00	1.00	1.00	1.00	1.00	5.00
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Minimizing pollution through (a) assisting in the establishment and enforcement of standards, and (b) providing criteria for land use planning

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	--	--	--	.06	.06	.06	.06	.24
DHEW	--	--	--	--	--	--	--	--
USDI	.05	.10	.10	.25	.25	.25	.25	1.10
Action								
USDA	.20	.25	.22	.47	.65	.65	.65	2.64
DHEW	--	--	.20	.30	.50	.69	.89	2.58
USDI	.05	.10	.25	.25	.25	.30	.30	1.40
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	.10	.15	.30	.30	.30	1.15
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Department and Legislation	Areas of Emphasis--Estimated Funding 1/																											
	Animal-management methods and facility design						Waste-treatment and disposal methods						Methods for converting wastes to useful products						Establishment and enforcement of standards and providing criteria for land use planning						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																											
USDA																												
Existing	1.20	11.80	.22	27.44	--	700.00	.20	4.00	.25	9.55	--	--	.10	3.80	.03	.15	--	--	--	.24	.25	2.64	--	--	1.50	19.84	.75	39.78	--	700.00
Proposed	--	--	--	240.12	--	568.20	--	--	--	564.63	--	1325.80	--	--	--	5.00	--	--	--	--	--	1.15	--	--	--	--	--	810.90	--	1894.00
DHEW																												
Existing	.03	--	--	.79	--	--	.30	.74	--	4.73	--	--	.16	1.42	--	5.54	--	--	--	--	--	2.58	--	--	.49	2.16	--	13.64	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																												
Existing	.06	.58	.15	4.50	--	--	.25	3.40	.35	19.50	--	--	.03	3.55	.08	3.20	--	--	.10	1.10	.10	1.40	--	--	.44	8.63	.68	28.60	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																												
Existing	1.29	12.38	.37	32.73	--	700.00	.75	8.14	.60	33.78	--	--	.29	8.77	.11	8.89	--	--	.10	1.34	.35	6.62	--	--	2.43	30.63	1.43	82.02	--	700.00
Proposed	--	--	--	240.12	--	568.20	--	--	--	564.63	--	1325.80	--	--	--	5.00	--	--	--	--	--	1.15	--	--	--	--	--	810.90		1894.00

1/ See tables for the individual Areas of Emphasis for footnotes.

WASTES FROM INDUSTRIAL PROCESSING OF RAW AGRICULTURAL PRODUCTS

I. The Problem

Precise estimates of the magnitude of wastes from processing agricultural products are not available. But a recent summary of published data indicates that their pollution potential expressed in pounds of biochemical oxygen demand (BOD) is equivalent to that produced by a population of more than 168 million people.

The Department of the Interior has assessed the situation, by industries, in its January 1968 Industrial Waste Profiles. Of the ten profiles completed, six concern agricultural products--paper mills, textile mill products, fruit and vegetables, leather tanning and finishing, meat products, and dairies. The petrochemical, metal and metal products, rubber, ceramic, and coal-based industries are the nonagricultural industrial sources of organic pollution. Table 2 was extracted from the profiles and provides an indication of the wasteload from some of the industries processing agricultural products.

The processing of agricultural products results in major problems in air and water pollution control and solid-waste management.

Waste from pulp and paper mills creates a broad range of pollution problems. One of the most significant but least understood effects is the toxicity to acquatic life caused by pulping wastes. The high waste concentration at the point of discharge causes acute toxicity, but the diluted material further downstream can still result in chronic toxicity to sensitive aquatic organisms.

Acidity and temperature changes of effluent streams also must be controlled. In most instances treatments are used to cool the waste waters. Acid waste waters are produced in acid sulfite processing and in bleaching.

Pulp and paper mill wastes may leave visual evidence of diminished stream quality. Sludge deposits can create turbidity and prevent the survival of numerous bottom-dwelling organisms. These deposits decompose slowly, usually anaerobically, producing locally toxic and odorous gases.

Effluents, even after treatment, are often heavily colored and turbid, which reduces light penetration and inhibits the development of aquatic organisms.

Similar problems arise in food and textile processing. The food and kindred products industry annually produces a BOD waste-load equivalent to four times the sewered population of the United States. Within the dairy-processing industry, the acid whey produced annually from

TABLE 2.--Comparison between reported waste load in 1963 and projected waste load for 1972

Industry	Total waste load in 1963			Total projected waste load for 1972	
	Product produced	BOD produced	Waste water produced	BOD produced	Waste water produced
	10^6 lbs	10^6 lbs	10^6 gals	10^6 lbs	10^6 gals
Pulp and paper------	35,000	2,670	868 x 10^3	2,910	990 x 10^3
Wool finishing--	412	132	26 x 10^3	133.2	28.4 x 10^3
Cotton fabrics----	2,015	528	97.6 x 10^3	526	100.1 x 10^3
Canned fruits and vegetables-	13,210	370	36 x 10^3	465	41.5 x 10^3
Frozen fruits and vegetables-	4,752	290	35 x 10^3	380	52 x 10^3
Leather tanning----	1,875	150	16 x 10^3	155	16 x 10^3
Meat products---	21,400	812	78 x 10^3	916	86 x 10^3
Dairy industry---	125,000	931	36 x 10^3	358	28 x 10^3
Poultry industry---	7,109	105	18 x 10^3	159	25 x 10^3

cottage-cheese processing amounts to a BOD equal to a population equivalent of 83 million people. Disposal or utilization of this enormous amount of liquid wastes presents serious difficulties.

The accumulation of solid wastes from processing crop and animal products is also a pollution problem. The culls, peelings, pits, trimmings, screenings, sludge, and other solid wastes generated are characteristic of each product and process. Many of these solid wastes pose troublesome fly and odor control problems because they contain large percentages of readily decomposed organic matter. Since the majority of these wastes are generated only during the harvesting season, disposal facilities may be used for only a month or two each year.

II. Methods and Effects of Control

Food-processing methods now in use were developed to minimize costs within the limitations of adequate sanitation and improved quality. Labor costs were such that material losses were not of primary concern. In recent years changes in production and processing methods, especially increased mechanization of harvesting and processing, have had effects on the pollution resulting from these operations, improving the situation in some instances but making it worse in others.

In recent years attention has been devoted to methods of harvesting that decrease the amount of solid and liquid wastes at the processing plant. Engineering advances, agronomic changes such as defoliation, and improved silvicultural practices--all can be effectively used to minimize wastes from processing plants.

Improved methods of peeling vegetables and fruit that will greatly reduce stream pollution are under study. For example, an essentially "dry" process of peeling potatoes with concentrated alkali and heat, followed by removal of the skin by a rubbing or beating operation, has great promise. The peelings can then be burned, disposed of as solids, or possibly fed to livestock. A reduction of 75 percent of the BOD of the effluent is estimated as a possible result.

Efficient separation and removal of solid wastes from the processing stream is an important factor in minimizing pollution. In all the animal-processing industries, 34 to 35 percent of the live weight must be converted into byproducts or removed as waste. In processing plant products, at least 20 to 30 percent must be converted or removed. The removal and disposal of this material without creating a pollution problem and at minimum cost are essential.

Examples of new processing methods under investigation include the elimination of alkaline scrubbing or washing of soybean oil to remove free fatty acids, recovery and reuse of pickling brines in olive and cucumber pickling, process and equipment modification to reduce spillage during milk processing, and development of new pulp bleaching and processing methods that will reduce wastes in the paper industry.

Recovery of byproducts, especially from concentrated and solid wastes, has been economic in various industries. Byproduct recovery also has been used to offset the net cost of waste treatment and sludge disposal.

Methods of drying citrus pulp and molasses for feed use were developed that bring a gross return of $27 million annually in Florida. A process for converting chicken feathers to feed meal was developed and has been widely adopted. Economic recovery and utilization of cheese sweet whey, supplemented as a proteinaceous food material has been developed. Correspondingly, the tremendous amounts of highly acid cottage cheese whey are also under investigation.

Studies are also underway on recovery of wastes from dairy and poultry processing for livestock feeds, recovery of protein from potato-processing wastes, use of the more concentrated waste fractions from fruit and vegetable processing for food and feed, and recovery and utilization of whole wood wastes, bark, and solid pulping wastes. An active area of research is the chemical and enzymatic conversion of cellulosic residues to ruminant feeds.

The Departments of the Interior; Agriculture; and Health, Education, and Welfare have programs relating to the treatment and control of wastes from the paper and pulp, textile-mill, food-processing, tanning, and dairy industries. The technology being developed and demonstrated will provide a basis for meeting the various State air- and water-quality and solid-waste management standards. Plans are being implemented by the respective Federal and State water-pollution agencies to meet existing water-quality standards by about 1972-75, depending on future financial commitments.

Where feasible, the use of processing effluents for irrigation or fertilization should be considered. The successful use and disposal of processing wastes by spray or ditch irrigation depend on suitable soil substructure, climatic conditions, characteristics of the waste, treatment necessary to make the effluent compatible with the intended use, and products grown.

It is probable that both air- and water-quality standards will be increasingly restrictive in the future. Advanced waste-treatment techniques will be necessary to meet these requirements. These tertiary treatment processes can produce effluents that equal or exceed current

potable water quality specifications. When this degree of treatment is required, a closed cycle, water reuse system can be used by processing plants with possible savings in cost.

Advancements in processing technology sometimes require changes in the nature of the agricultural raw materials used. Conversely, changes in raw materials sometimes require or permit processing changes. In addition, harvesting or handling procedures resulting from engineering advancements or limited labor supplies sometimes necessitate or permit significant changes in the characteristics of crop or forest plants or their products.

Improved cultural practices and genetic changes affecting the composition and quality of agricultural raw materials and the amount of residual substances associated with them are among the important avenues open for progress in modifying processing wastes.

Crop and forest geneticists are breeding new varieties that are better suited to mechanical harvesting, have fewer or more easily removed leaves and less trash, etc. This is a long-range approach to minimizing wastes from processing. Research on cleaner harvesting methods that would keep soil and plant residues on the farm will also reduce processing problems.

III. Areas of Emphasis

Emphasis in research and action programs should be placed in the following areas.

1. Modernization of harvesting and processing

In the past, research of the Department of Agriculture has been directed primarily toward increased efficiency and reduction of labor requirements. In recent years studies designed to reduce wastes and pollution by process changes, including those to minimize polluting effects of effluents, have received new emphasis. For example, it is anticipated that current research on peeling of fruits and vegetables and improving wood-pulping processes will effect major reductions in waste loads from processing plants. USDA also has technical assistance and extension programs designed to advise and transmit research results to processing industries.

The Department of Health, Education, and Welfare has no program in this area.

The Department of the Interior also is concerned with process modifications where these have a direct effect on reducing the quantity of wastes to be treated in order to effectively control the quality of the liquid effluent discharged to the environment. The Department has a treatment and control research effort and has awarded grants to the agricultural products processing industry that include modifications that, in turn, result in more effective or economical means of reducing water pollution. The ultimate goal is to have completely closed cycles that permit total water reuse and provide for utilization of any solids wasted in processing or generated by the treatment process itself.

In addition, USDI has technical and R&D grant assistance programs designed to advise and to transmit research results to processing industries.

2. Byproduct recovery and utilization

The Department of Agriculture research program in this area is concerned principally with developing uses for processing plant wastes. Utilization of wood-processing byproducts also is receiving attention. A technical assistance program is conducted to provide industry with the results of research efforts.

The Department of Health, Education, and Welfare has a number of research grants directed toward further studies of the potential for using various types of waste. These studies are directed toward developing processes and end products that provide an economic return similar to that experienced by the citrus industry in processing their solid wastes as animal feed.

In the treatment of effluent streams, solids are removed during the various unit processes. As a means for disposing of those solids, some of the projects of the Department of the Interior include demonstration of the conversion of these waste solids to useful products, such as cattle feed, and also include demonstration projects at full scale that will enable recycling the treated effluent into a plant's operational system. USDI also supports activities relating to wood-byproducts utilization and conducts a technical assistance program with national trade organizations.

3. Treatment and disposal of wastes from processing plants

The Department of Agriculture has a number of active research projects in this area. The land disposal of processing wastes through spray and trench irrigation and subsurface disposal has received considerable attention. These studies include the effects of disposal on soil chemistry and physics as well as on plant development. USDA provides technical advice to processors on efficient waste disposal.

The Department of Agriculture also is authorized to make loans and grants to public bodies and nonprofit organizations primarily serving or providing substantial benefits to farmers and rural residents to develop water-supply and waste-disposal systems in communities of less than 5,500 population. The agency has an ongoing program and has financed systems in rural areas that service agricultural processing plants. Broader authorities are not needed to increase the program to the estimated level of the proposed 5-year period. But a substantial increase in the loan and grant funding levels is considered necessary.

It has been estimated that 8,000 food-processing plants are located in rural areas. Treatment for most of these plants will probably be furnished in connection with treatment facilities serving the community in which they are located. Availability of loans for developing treatment facilities is a strong incentive for industry to locate in a rural community.

The Department of Health, Education, and Welfare has a strong and deep interest in the area of industrial solid-wastes disposal. In compliance with the responsibilities delegated to it by the Solid Wastes Disposal Act, activities in industrial waste utilization and disposal are continually expanding.

For example, DHEW has recently entered into a research grant contract with the National Canners Association to conduct a study of the solid-waste production by the total food-processing industry, including the canning, frozen food, and dehydrated food product segments. The results of this study will permit better definition of the problem both in terms of its magnitude as well as in identifying areas in which further productive research studies might be conducted.

In addition, DHEW has instituted research on the problems associated with the incineration of low-density, high-BTU solid waste such as peanut hulls and cotton-ginning residues. Current incinerator designs are not adequate to handle these types of materials nor have the incineration methods been explored from the standpoint of possible production of power or heat.

A number of studies also are underway regarding the disposal of certain of the liquid wastes produced by the degradation of the solid waste products resulting from food-production operations. Land-injection methods might offer some potential. DHEW recently has awarded a research grant that will produce information on ocean disposal of wastes, together with consideration of the ecological problems that might result from using the ocean as a disposal area. This study should be useful in pointing up fruitful areas for further research as well as in defining the critical balances that might be disturbed in the ecology of the ocean with particular reference to its detrimental effects on marine life.

For the first time in the history of water pollution, the Clean Water Restoration Act of 1966 enabled the Department of the Interior to participate directly with industry to demonstrate new or improved methods for abating pollution. The Department can participate up to 70 percent of the total cost of these projects. Accordingly, since 1966, the Department has engaged in an extensive program to encourage industry to demonstrate effective methods for cleaning up pollution. The agricultural-products processing industry has been most aggressive in this regard. Numerous methods and systems are being demonstrated for the removal of pollutants from plant effluents.

USDI presently has ongoing grants in most of the food-processing industry, demonstrating a variety of treatment and recovery techniques. A few of the areas under investigation include reprocessing of olive brines as a means of treatment, since conventional lagooning results in salt-water intrusion into the ground water; secondary treatment of potato-processing wastes to include recovery of primary solids for conversion into cattle feed; a completely closed system for the citrus-processing industry will be operational by early 1969; joint efforts with USDA will evaluate recovery of cottage cheese acid whey. Work

is also planned for the treatment and recovery of paunch manure for conversion into cattle feed, recovery of edible oils in margarine manufacturing, treatment of rum-distillery wastes, etc.

Future work will continue to be directed into areas that will systematically develop improved and more economical forms of treatment for each of the industries under the food and kindred category.

Efforts are also being directed toward the treatment of cannery wastes and other seasonal operations to permit their continued use of municipal treatment systems.

4. Changes to make agricultural raw materials that are more readily processed

Fruit, vegetable, and forest geneticists in the Department of Agriculture are breeding new varieties that are better suited to mechanical harvesting, have less or more easily removed leaves and trash, etc. But reduction of pollution is necessarily a secondary consideration to product quality, yield, and similar considerations.

The Department has a small technical assistance program in which it works with the research arms of the Department and the States and with the farmers and processing industry.

The Departments of Health, Education, and Welfare and the Interior have no programs in this area.

WASTES FROM INDUSTRIAL PROCESSING OF RAW AGRICULTURAL PRODUCTS

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from processing wastes. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

Modernization of harvesting and processing

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.42	.86	2.51	3.11	3.19	3.08	3.00	14.89
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	.23	.25	.28	.32	.34	.38	.39	1.71
DHEW	--	--	--	--	--	--	--	--
USDI	1.80	2.50	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	6.80	8.70	6.50	4.00	3.00	29.00
Loan Level								
USDA	--	--	--	--	--	--	--	--

Byproduct recovery and utilization

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.43	.65	1.59	1.86	2.14	2.23	2.60	10.42
DHEW	.16	.16	.15	.25	.30	.33	.45	1.48
USDI	--	--	--	--	--	--	--	--
Action								
USDA	.05	.05	.09	.12	.15	.19	.22	.77
DHEW	--	--	.30	.65	.95	1.50	2.20	5.60
USDI	1.08	1.50	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	3.90	5.20	4.00	2.00	1.00	16.10
Loan Level								
USDA	--	--	--	--	--	--	--	--

Treatment and disposal of wastes from processing plants

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.10	.18	.35	.56	.65	.70	.80	3.06
DHEW	.30	.30	.10	.15	.18	.20	.20	.83
USDI	.20	.25	--	--	--	--	--	--
Action								
USDA	.44	.52	3.50	6.24	9.78	13.02	18.94	51.48
DHEW	--	--	.50	.80	1.00	1.15	1.30	4.75
USDI	5.50	8.00	--	--	--	--	--	--
Loan Level								
USDA	2.00	2.00	10.00	20.00	30.00	40.00	60.00	160.00
Proposed Legislation								
Research and Development								
USDI	--	--	1.00	1.10	1.20	1.30	1.40	6.00
Action								
USDA	--	--	2.13	2.13	2.13	2.13	2.13	10.65
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	23.00	34.00	39.00	30.00	15.00	141.00
Loan Level								
USDA	--	--	--	--	--	--	--	--

Changes to make agricultural raw materials that are more readily processed

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.13	.15	.18	.20	.28	.35	.37	1.38
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	.04	.04	.04	.06	.08	.09	.11	.38
DHEW	--	--	.10	.10	.15	.20	.25	.80
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Department and Legislation	Modernization of ha				Total					
	Research and Development		Ac	el	Research and Development		Action		Loan Level	
	1969	5-year	196	5-year	1969	5-year	1969	5-year	1969	5-year
USDA										
Existing	.86	14.89	.25	--	1.84	29.75	.86	54.34	2.00	160.00
Proposed	--	--	--	--	--	--	--	10.65	--	--
DHEW										
Existing	--	--	--	--	.46	2.31	--	11.15	--	--
Proposed	--	--	--	--	--	--	--	--	--	--
USDI										
Existing	--	--	2.5(	--	.25	--	12.00	--	--	--
Proposed	--	--	--	--	--	6.00	--	186.10	--	--
TOTAL										
Existing	.86	14.89	2.7	--	2.55	32.06	12.86	65.49	2.00	160.00
Proposed	--	--	--	--	--	6.00	--	196.75	--	--

1/ See tables for the individual Areas of E

Department and Legislation	Areas of Emphasis--Estimated Funding 1/																											
	Modernization of harvesting and processing						Byproduct recovery and utilization						Treatment and disposal of wastes from processing plants						Agricultural raw materials that are more readily processed						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																											
USDA																												
Existing	.86	14.89	.25	1.71	--	--	.65	10.42	.05	.77	--	--	.18	3.06	.52	51.48	2.00	160.00	.15	1.38	.04	.38	--	--	1.84	29.75	.86	54.34	2.00	160.00
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	10.65	--	--	--	--	--	--	--	--	--	--	--	10.65	--	--
DHEW																												
Existing	--	--	--	--	--	--	.16	1.48	--	5.60	--	--	.30	.83	--	4.75	--	--	--	--	--	.80	--	--	.46	2.31	--	11.15	--	--
Proposed	--	--	--	--	--	--	--	--	---	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																												
Existing	--	--	2.50	--	--	--	--	--	1.50	--	--	--	.25	--	8.00	--	--	--	--	--	--	--	--	--	.25	--	12.00	--	--	--
Proposed	--	--	--	29.00	--	--	--	--	--	16.10	--	--	--	6.00	--	141.00	--	--	--	--	--	--	--	--	--	6.00	--	186.10	--	--
TOTAL																												
Existing	.86	14.89	2.75	1.71	--	--	.81	11.90	1.55	6.37	--	--	.7	3.89	8.52	56.23	2.00	160.00	.15	1.38	.04	1.18	--	--	2.55	32.06	12.86	65.49	2.00	160.00
Proposed	--	--	--	29.00	--	--	--	--	--	16.10	--	--	--	6.00	--	151.65	--	--	--	--	--	--	--	--	--	6.00	--	196.75	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

PLANT NUTRIENTS

I. The Problem

Plant nutrients, as used here, are inorganic chemicals essential for the mineral nutrition of plants. Included are the major fertilizer elements, nitrogen, phosphorus, and potassium; secondary elements, calcium, magnesium, and sulfur; and micronutrients such as iron, manganese, zinc, copper, and boron. These elements are normal constituents of fertile soils and are vital in the production of food and fiber.

Of the elements essential for plant growth, phosphorus and nitrogen are of particular concern in connection with pollution. These plant nutrients can move into streams, lakes, and reservoirs, and nitrate nitrogen can move into ground water. The sources of these elements may be several, for example, farm and ranch land, barnyards and feedlots, municipal and rural sewage, and industrial wastes. This report deals only with plant-nutrient pollution resulting from agricultural pursuits.

Excessive intake of nitrate in drinking water can be a precursor to nitrite formation in babies' stomachs causing methemoglobinemia. Excessive nitrate in water or feed may also be toxic to ruminant livestock.

Nutrients in surface waters may become contaminants in that they contribute to undesirable growth of aquatic plants. This adversely affects the body of water for fish, recreational use, or human consumption. Nitrogen and phosphorus are the two elements that generally limit growth of such plants, but other elements such as potassium may be involved.

Algae in small quantities are beneficial in that they add oxygen to water and provide fish food. But the excessive algal "blooms" that frequently develop in nutrient-laden waters may impart an off-taste and an unpleasant odor to the water. They clog sand filters and modify the color, alkalinity, hardness, and turbidity of the water. Under severe conditions, algae produce substances that may be toxic to fish, animals, and human beings and bring about accelerated eutrophication of lakes and streams, rendering them "dead" or virtually useless in time. Plankton algae are the most prolific of the undesirable aquatic plants and are cosmopolitan in their distribution. They occur in great abundance in oceans, salt lakes, freshwater lakes, ponds, and streams.

In view of the rapid rate of eutrophication of so many of our lakes and estuaries, efforts related to the cause and control of this process are of extreme importance.

Nitrogen.--Although many soils still supply substantial proportions (50 to 75 percent is not uncommon) of the nitrogen needs of crops, the increased demands for nitrogen imposed by higher yielding varieties and generally

improved farming practices has caused nitrogen-fertilizer use to climb almost linearly over the past few decades. In 1967, annual consumption for the United States reached approximately 6 million tons of nitrogen. With continued intensive agriculture and ever-increasing yield potentials, the consumption of fertilizer nitrogen will rise to much higher levels. In recent years, forest fertilization also has been increasing.

A pollution problem may arise (1) if available nitrogen exceeds withdrawal by the crop and (2) if the amount of water available to the crop exceeds the amount consumed, the amount lost by evaporation, or the capacity of the soil to absorb or store it. Production under irrigation with intensive fertilizer practices could result in serious ground-water pollution.

The increasing application of liquid ammonia fertilizer may contribute to air pollution as well as to water pollution. This material is released into the atmosphere in gaseous form and is readily soluble in water.

Phosphorus.--Phosphorus is a major nutrient controlling the fertility of natural waters. Small increases in phosphorus concentrations stimulate the growth of blue-green algae and other organisms. Algal growth is limited by phosphorus concentrations below 0.01 parts per million, but concentrations of 0.05 parts per million or higher permit profuse growth.

Much has been written about the sources of phosphorus responsible for raising the phosphorus concentrations in water, e.g., detergents, sewage, food-processing wastes, animal wastes. We are concerned here with the contribution of soil phosphorus and fertilizer phosphorus applied to the land. Most of the applied phosphorus fertilizer becomes so strongly fixed to clay surfaces that almost none moves downward by water percolation. Thus repeated fertilization can build up the level of total phosphorus in the upper part of soils to much higher levels than present originally.

Phosphorus is carried on eroded soil particles into streams and surface-water systems. An analysis of sediment-laden water may show as much as 10 parts per million; yet the phosphorus in true solution may be only 0.01 parts per million or less. The main avenue of phosphorus entry into water supplies from fertilizers, therefore, is soil erosion. The best ways to control this problem in streams are to guard against overfertilization and to reduce watershed and stream bank erosion.

Potassium and other elements.--Soils that contain relatively high percentages of silt and clay are usually well supplied with potassium. Drainage waters from fields usually carry away a considerable amount of this element, and it is sometimes necessary to add potassium fertilizer in farming operations.

The other elements essential for plant growth are usually present in soils in sufficient quantities and are not important from a pollution standpoint. But there are exceptions. For example, boron is naturally present at

toxic levels in several areas of the San Joaquin Valley in California. In some orchards in Florida and South Carolina copper and zinc have accumulated to toxic levels from pesticide use.

II. Methods and Effects of Control

Programs are required that maximize fertilization benefits and minimize environmental pollution, particularly in localities where nutrient contamination may be excessive.

Control of excess nutrients arising from fertilizer application rests ultimately on a better understanding of the movement and ultimate fate of these materials. Data obtained from monitoring nutrient concentrations in distinctive and important agricultural areas and forests could be used to assess the relative importance of the fertilizer contribution to the nutrient problem. Clarification of nutrient transportation and deposition mechanisms may furnish new leads to control.

Additional information on the potential danger of excess nitrogen accumulation in food plants, water, soil, and air would provide an assessment of the emphasis that should be placed in each area. Better knowledge of the fate of liquid-ammonia applications along with nitrogen contamination of the environment resulting from fertilizer distribution at different times during the year also would be useful.

Existing technology can be utilized to make more effective use of fertilizer in crop production. The improvement and application of information on predicting nutrient content and availability in soils to determine the need for supplemental fertilizer application and on crop and fertilization management programs that minimize the release of nutrients to receiving waters could result in meaningful reductions in nutrient contamination of the environment.

There are also opportunities to treat or remove plant nutrients from surface or subsurface water. Progress has been made in developing techniques for removing trace elements from sewage and industrial wastes. The diffuse sources of nutrients from agricultural operations makes the application of these techniques more difficult, but there are situations where water treatment or removal may be appropriate, for example, in irrigation return flows.

Improved knowledge of the effect of nutrients on the growth of algae and noxious water plants could lead to control through maintaining nutrient content of the water below growth-promoting levels. Methods might be developed for rendering nutrients unavailable for plant growth in receiving waters. Means might be developed for preventing the release of nitrogen and phosphorus from sediments. Biological and chemical control of algae

and other water weeds may be feasible under some conditions. Micro-organisms (plant disease), insects, snails, higher animals, and herbicides might be used to prevent excessive growth of water plants.

In recognizing that control of water plants may not always be feasible, opportunities for their utilization as food or feed or other useful products should be pursued. Even if successful methods are developed for eliminating nutrients from receiving waters, present concentrations and attendant plant growth will persist for considerable periods of time. This is further justification for efforts in this area.

III. Areas of Emphasis

The following areas merit principal attention in combatting the excess nutrients problem.

1. Behavior and fate of applied nitrogen, phosphorus, and other nutrients

In the Department of Agriculture, most of the research on the behavior and fate of applied nutrients has been directed toward determining the most effective use of fertilizer applications. Studies have included experiments on (a) yield response of crops to increasing rates of fertilization; (b) correlation of yield response or nutrient uptake with soil analyses as a basis for developing reliable soil testing methods to aid in predicting optimum fertilization levels; (c) time and frequency of fertilizer application to define means of obtaining the most efficient use of applied nutrients; and (d) determining sources of nutrients most appropriate for different soil areas, crops, and management systems. Associated laboratory investigations have revealed some of the fundamental relations between chemical properties of soils and behavior of applied nutrients under different climatic situations.

One of the least understood aspects of nitrogen fertilizer behavior concerns the part of applied nitrogen that is lost to the atmosphere in gaseous forms, e.g., as elemental nitrogen gas or gaseous oxides of nitrogen. The extent to which gaseous losses occur under field conditions, owing to chemical or biological mechanisms operating in the soil, and the significance of such losses in alleviating nitrogen pollution of ground water are unknown. Clarification of this problem may provide avenues for (a) improving fertilizer-use efficiency and (b) controlling or manipulating gaseous losses to minimize opportunities for groundwater contamination.

The Department of Health, Education, and Welfare is directing effort to determine the impact plant nutrients have on drinking water supply and public health. Information and technology are being generated by--

(a) Epidemiological studies of water quality and disease
(b) Studies of the behavior and control of contaminants in surface waters
(c) Investigation of health parameters applicable to reclaimed waste waters

Another study involving surveillance of drinking-water quality includes many quality constituents that are contributed by agricultural pollution.

Because of the deleterious effects of nutrients on water quality, the Department of the Interior has an extensive in-house and extramural

program to determine the fate, behavior, and availability of the numerous forms of nutrients in receiving waters. The Department also has extensive programs to determine the effects on food-chain productivity, which in turn affects fish productivity, and on the fate of nutrients resulting from irrigation practices.

2. Minimizing runoff and percolation of nutrients by using them more effectively

Existing authorizations are adequate for the Department of Agriculture to conduct research and action programs in this area. Information on nutrient runoff in relation to soil type, slope, crop management, and storm characteristics has been derived from small-plot field installations. More recently, larger scale watershed studies have begun to include measurements of nutrient losses as an incidental part of the more detailed studies of soil and water movements occurring within the watershed. Information on downward percolation of nutrients, particularly nitrate nitrogen, is being obtained from vertical profile samplings under fertilized fields and feedlots.

With increasing use of fertilizers, the opportunities for nutrient losses and the probability that such losses will occur also increase. More information is needed about the behavior of nutrients in soils under high fertilization for action effective in minimizing losses with various systems of farm and forest management involving different levels of fertilizer use.

The Department of the Interior has programs in irrigation practices, concerned with their effect on uptake or runoff of plant nutrients.

3. Controlling, treating, or removing excess plant nutrients from surface or subsurface drainage to maintain the desired quality of receiving waters

Research and action programs in the Department of Agriculture largely have involved development and establishment of systems for controlling entry of contaminated waters into lakes and other bodies of water, e.g., terracing, diversion ditches, grassed waterways, and ponds. Existing authority has been adequate for these programs.

In the future, increasing emphasis may be given to developing means of reducing the nutrient concentration in drainage water before its release into the receiving body. Use of the nutrient-adsorption properties of soil itself or of synthetic ion exchangers has undergone extensive research. Long-term projections might even envision application of desalinization methods involving low-cost power. USDA envisions that

additional authorization would be required for providing financial assistance to put into action some of the schemes for nutrient removal or water treatment that might evolve from concerted research efforts in this area.

The Department of Health, Education, and Welfare in its activity to assure the Nation safe drinking water standards maintains a continuing surveillance of drinking-water quality. Many of the quality constituents are contributed by agricultural pollution, including plant nutrients. Closely associated with this effort is the research and development activity to determine the behavior and means of controlling contaminants in surface waters.

Because of its mandate to insure the quality of receiving waters, the Department of the Interior has extensive programs to minimize and remove significant amounts of nutrients released to these streams, rivers, etc. Advantage is being taken of the large program in preventing and abating nutrient contributions from municipal and other industrial sources for application to problems associated with irrigation.

4. Effects of nutrients on algae and noxious water plants

The limited current efforts in research by the Department of Agriculture in this area are directed toward determining nutrient requirements of these organisms. The Department anticipates that expanded research on algae would be coordinated with studies on the nutrient composition of water in relation to sources of such nutrients. Involved, for example, is the question of the limiting or critical phosphorus concentrations for algal growth and the role of sediment-borne phosphorus in supplying this element. Action and research phases relating to control of algal growth would be concerned with (a) suppressing algal growth in water potentially capable of supporting noxious levels and (b) keeping nutrient concentrations below the levels considered to be critical for growth.

The Department of the Interior is concerned with the deleterious effect of algal growths and aquatic weeds on water quality as well as in the operation of water-resource developments. In order to determine and develop realistic water-quality standards for nutrient concentrations in receiving waters, it is necessary that the Department determine the temporal quality-quantity relationships of the nutrient-algae regime. Accordingly, a large part of the in-house program and a significant part of the extramural research is included in this area.

5. Use of harvested algae and other water plants

One method that has been suggested for lowering the nutrient content of water involves growing algae to consume nutrients, followed by harvesting the algae or other water plants. Such an approach is worthy of further study, provided economic means of utilizing the harvested product can be devised. Some research is underway in the Department of Agriculture on using algae as an animal feed supplement. The Department foresees that further research is needed to evaluate the intrinsic value of algae in animal nutrition in relation to their biochemical components and to determine in feeding trials their value as a supplement to low-protein feeds. Harvesting and processing methods for algae also will require research and development.

The Department of the Interior considers the extraction of algae from the water cycle as one of many water-treatment methods for nutrient removal. In-house and extramural projects are directed toward developing process systems to effectively implement this concept. As in other treatment processes, the solid residue, in this case the algae, must be either digested or converted to useful products. Research in this area indicates the latter approach could be economically justified.

Several grant demonstration projects associated with or without agricultural wastes will be used by USDI to provide the necessary engineering data to verify completed pilot plant studies.

PLANT NUTRIENTS

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from plant nutrients. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

DHEW figures for plant nutrients include some funds expended on inorganic salts and minerals.

Behavior and fate of applied nitrogen, phosphorus, and other nutrients

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.98	1.18	1.40	1.60	1.80	2.00	2.15	8.95
DHEW 1/	.02	.02	.03	.04	.05	.06	.07	.25
USDI	.73	.75	-	-	-	-	-	-
Action								
USDA	.05	.05	.05	.05	.05	.05	.05	.25
DHEW	.01	.01	.01	.02	.02	.03	.03	.11
USDI	.80	.80	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	1.00	1.00	.75	.50	.50	3.75
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	.12	.13	.13	.05	.05	.48

1/ The projected funding is only a rough estimate of the portion of Bureau of Water Hygiene programs devoted to plant nutrients.

Minimizing runoff and percolation of nutrients by using them more effectively

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.25	.28	.45	.55	.70	.80	.95	3.45
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	.23	.43	.53	.93	2.73	3.65	4.55	12.39
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Controlling, treating, or removing excess plant nutrients from surface or subsurface drainage to maintain the desired quality of receiving waters

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	-	.03	.15	.35	.50	.70	.80	2.50
DHEW 1/	.01	.01	.01	.02	.02	.02	.03	.11
USDI	1.25	1.45	-	-	-	-	-	-
Action								
USDA	.52	.42	.72	1.52	2.42	3.02	3.82	11.50
DHEW	.01	.01	.01	.02	.02	.03	.03	.11
USDI 2/	12.00	10.00	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	1.50	1.00	1 .00	.75	.75	5.00
Action								
USDA	-	-	.40	.50	1.30	2.00	4.00	8.20
DHEW	.01	.01	.01	.02	.02	.03	.03	0.11
USDI	-	-	30.00	50.00	50.00	40.00	40.00	210.00

1/ The projected funding is only a very rough estimate of the portion of Bureau of Water Hygiene programs devoted to plant nutrients.

2/ This type of activity is an integral part of the Municipal Treatment R&D demonstration program and cannot be separated from the total. The funds indicated are the sums for all projects which include nutrient removal.

Effects of nutrients on algae and noxious water plants

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.05	.06	.10	.10	.15	.20	.20	.75
DHEW	-	-	-	-	-	-	-	-
USDI	.35	.40	--	-	-	-	-	-
Action								
USDA	.19	.27	.27	.27	.27	.27	.27	1.35
DHEW	-	-	-	-	-	-	-	-
USDI	-	.18	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	.50	.50	.30	.25	.25	1.80
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	1.00	1.20	1.50	1.50	1.50	6.70

Use of harvested algae and other water plants

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	-	-	.10	.10	.15	.20	.20	.75
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	.30	.50	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	--	-	-	-
DHEW	-	-	-	-	-	-	-	--
USDI	-	-	.75	.75	.75	.50	.30	3.05

Department and Legislati	Use of harvested algae and other water plants						Total					
	ch and pment	Action		Loan Level			Research and Development		Action		Loan Level	
	5-year	1969	5-year	1969	5-year		1969	5-year	1969	5-year	1969	5-year
USDA												
Existi	.75	--	--	--			1.55	16.40	1.17	25.49	--	--
Propos	--	--	--	--			--	--	--	8.20	--	--
DHEW												
Existi	--	--	--	--			.03	.36	.02	.22	--	--
Propos	--	--	--	--			--	--	--	.11	--	--
USDI												
Existi	--	.50	--	--			2.60	--	2.48	--	--	--
Propos	--	--	3.05	--			--	10.55	--	220.23	--	--
TOTAL												
Existi	.75	.50	--	--			4.18	16.76	3.67	25.71	--	--
Propos	--	--	3.05	--			--	10.55	--	228.54	--	--

1/ See tab

Areas of Emphasis--Estimated Funding 1/

Department and Legislation	Behavior and fate of applied nitrogen, phosphorus, and other nutrients						Using nutrients more effectively						Controlling, treating, or removing excess plant nutrients from surface or subsurface drainage						Effects of nutrients on algae and noxious water plants						Use of harvested algae and other water plants						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																																			
USDA																																				
Existing	1.18	8.95	.05	.25	--	--	.28	3.45	.43	12.39	--	--	.03	2.50	.42	11.50	--	--	.06	.75	.27	1.35	--	--	--	.75	--	--	--		1.55	16.40	1.17	25.49	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	8.20	--	--	--	--	--	--	--	--	--	--	--	--		--	--	--	8.20	--	--
DHEW																																				
Existing	.02	.25	.01	.11	--	--	--	--	--	--	--	--	.01	.11	.01	.11	--	--	--	--	--	--	--	--	--	--	--	--		.03	.36	.02	.22	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.11	--	--	--	--	--	--	--	--	--	--	--	--		--	--	--	.11	--	--
USDI																																				
Existing	.75	--	.80	--	--	--	--	--	--	--	--	--	1.45	--	1.00	--	--	--	.40	--	.18	--	--	--	--	--	.50	--	--		2.60	--	2.48	--	--	--
Proposed	--	3.75	--	.48	--	--	--	--	--	--	--	--	--	5.00	--	210.00	--	--	--	1.80	--	6.70	--	--	--	--	--	3.05	--		--	10.55	--	220.23	--	--
TOTAL																																				
Existing	1.95	9.20	.86	.36	--	--	.28	3.45	.43	12.39	--	--	1.49	2.61	1.43	11.61	--	--	.46	.75	.45	1.35	--	--	--	.75	.50	--	--		4.18	16.76	3.67	25.71	--	--
Proposed	--	3.75	--	.48	--	--	--	--	--	--	--	--	--	5.00	--	218.31	--	--	--	1.80	--	6.70	--	--	--	--	--	3.05	--		--	10.55	--	228.54	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

FOREST AND CROP RESIDUES

I. The Problem

Forest residues

Forest residues come primarily from two sources--man's activities and natural accumulation. Man-made residue is caused primarily by timber harvest, land clearing, and forest cultural work. Natural residues are the byproducts of forest growth, pest depredation, maturity, and subsequent deterioration. Highly inflammable needle litter in the uncut southern pine forests and timber killed by insects and disease are examples of natural residue.

Timber-harvesting operations in the United States leave an estimated 25 million tons of debris in the woods each year. Some of this is beneficial to the soil and microclimate for new crops, but much of it is also an exceedingly serious fire hazard and a reservoir for diseases and pest insects. On the average, forest fires that start in logging waste are more than seven times as large as those that start in cut areas where the waste has been removed. Millions of dollars are spent each year to dispose of waste on a part of the forest area harvested. Residues on much of the harvested area, however, receive little or no attention.

Losses from fires in both cut and uncut forests are very serious. During the past 10 years an average of 111,800 fires per year burned 4.6 million acres annually. Losses in resources burned and firefighting costs may reach one billion dollars annually. In addition, there are many homes and some lives lost, beautiful scenery destroyed, watersheds damaged, and other losses on which it is difficult to place a monetary value.

Forest wildfires have been estimated to release annually into the atmosphere 160 cubic miles of smoke, 34 million tons of particulates, and 338,000 tons of hydrocarbons. Burned forest areas have excessive runoff and very high sediment delivery. Ash washed into streams kills fish, pollutes water for domestic and industrial use, and may make water unsuitable for irrigation and recreational use.

Some logging residue is chipped, buried, crushed, or masticated, but this is very expensive at the present time. Such methods often cost several times as much as burning. Studies have shown chipping to cost $60 per acre in South Dakota. Crushing costs were $20 to $25 per acre in studies made in Wyoming.

Elms killed by Dutch elm disease and oaks killed by oak wilt must be destroyed or treated to prevent vector transmission of the diseases to healthy trees. Logging slash is an excellent host for ips beetles,

which are particularly destructive to young pine trees in cutover areas. Trees killed by fires or by insects and disease and not utilized (salvaged) continue to be a serious fire hazard for many years.

Crop residues

Residues from crops and orchards contribute to pollution as sources of smoke and other air pollutants when burned and as reservoirs of plant diseases and other pests. Also, accumulations of decaying plants such as pea vines in the fields often cause obnoxious odors.

Agricultural wastes from orchards, grain fields, and rangeland, especially in Western United States, are burned as the most practical means of disposal. In one California county in 1960, an estimated 41,000 tons of orchard wastes were burned. From 30 to 80 percent of approximately 240,000 acres of rice stubble in eight California counties is burned annually. The smoke can be seen for miles.

About 900,000 acres of grass are grown for seed each year, producing about 2 tons of residue per acre. Estimates indicate that about one-third of this acreage is burned each year as a sanitation measure. Such burning emits about 50,000 tons of particulate matter as carbon and ash into the atmosphere. Sugarcane burning is commonly done to aid harvesting.

Evaluations have been made of the relative contribution the burning of agricultural wastes makes to photochemical air pollution. The studies indicated that concentrations of photochemically active hydrocarbons were negligible at a mile and a half from the fire even when large areas of wastes were burned. Emissions of hydrocarbons and oxides of nitrogen from burning agricultural wastes were considerably less per ton of fuel consumed than those in auto exhaust. Burning of fruit-tree prunings, rice straw, barley straw, and dry native range brush produced approximately 14, 9, 18, and 7 pounds of hydrocarbons, respectively, compared with 130 pounds of the same hydrocarbons in auto exhaust per ton of fuel consumed. Much remains to be learned about the extent to which the burning of agricultural wastes adds to the burden of pollutants in air. Certainly the effects on visibility may be a significant esthetic factor.

Piles of peanut litter, rotting hay, and straw provide suitable breeding places for the stable fly and housefly. Volunteer wheat, resulting from grain waste in inefficient harvesting, provides a breeding ground for the wheat curl mite, the vector of wheat streak mosaic. Volunteer beets are a source of beet yellow virus for reinfection of subsequent beet crops in Western and Northwestern United States. Pink bollworms overwinter in waste cotton bolls and cotton seed left in fields. The European corn borer and sugarcane borer overwinter in the stalks remaining in the fields. Many additional situations involving large economic losses are known.

Late blight of potato, cotton verticillium wilt and bacterial blight, apple scab, brown rot of stone fruits, and leaf spot of tung are examples of plant diseases associated with plant residues. The extent of damage is not always known, but some estimates have been made. For example, observations indicate that piles of culled potatoes are the primary sources of infection for late blight, a disease that causes an estimated average 4 percent loss of the potato crop each year.

II. Methods and Effects of Control

Forest residues

Over the years, research, equipment development, and experience have generated much capacity to handle forest residues. Both government and private forest managers are using present knowledge in varying ways to clean up or utilize residue, and most of their efforts are effective. More can be done. Some of what's being done can be altered to enhance the quality of total environment more effectively.

One attack is to reduce the amount of residues produced and to protect against losses to which they contribute. For example, improved fire protection would make it possible "to live with" debris left on land without the present risks of large and damaging fires.

Although the point of diminishing returns is not clearly established, studies have shown that increased fire protection is a prudent investment. The most promising measures to reduce the incidence of large, damaging fires are to (1) strengthen initial attack forces, (2) establish fuelbreaks, (3) convert flammable forest types to less flammable species, and (4) prevent fires from starting. These measures reduce the need for disposing of natural debris by burning and decrease the need for treating man-caused debris. Progress in protection will require more emphasis on selected parts of the program where cost-benefit studies show the payoff to be substantial.

A second efficient course for handling woods waste is to use more of it.

Greater demand for raw wood and better prices have made it economically possible to take a far greater percentage of the wood material out of the forest than formerly. As the demand for wood grows, there have been many cases of relogging the forest two, three, and even more times to take out material not economical the first time. Some prelogging utilization of special products is also done. Less desirable timber trees plus tops, limbs, and pieces of logs are being used for pulp chips, fuelwood, mulch, posts and other products.

In addition, forest residues can be reduced through better utilization of logging debris and diseased and fire-killed timber. Steady progress has been made in the past. But to continue progress in some areas new markets will have to be developed, i.e., pinyon-juniper forests now cleared and burned to improve range in the Intermountain West might be partially used for attractive lathe-turned wood products.

Another great opportunity to reduce forest residue and improve utilization is through operations where all usable forest products on the land being worked are removed to market in a fully integrated operation.

Currently, opportunities for alternatives to burning residues are limited primarily to (1) chipping of debris in selected areas and (2) in some climatic zones lopping off and scattering slash and getting it near the ground where it will rot faster. Equipment is needed that will do a better and cheaper mastication of logging waste that would keep it on the area but materially lessen the fire hazard. Such material would improve the soil and reduce erosion if left in place.

So far, burning is the most universal method used to dispose of forest residues. It is fairly economical. It frequently stops disease and kills pests. It reduces forest fuels and thereby minimizes the likelihood of destructive wildfires. Under many ecological conditions it promotes desirable forest regeneration. In some forests fire is necessary to get any regeneration at all. But combustion products are cast into the atmosphere. Only recently has smoke from burning forest residue been recognized as an atmospheric pollutant. Even though its toxic qualities are unproved, forest managers and agencies are seeking methods and times of burning so that smoke disperses widely into the atmosphere.

Fire-control specialists are becoming more expert at applying fire of the intensity needed to reduce residue, to create ideal forest-regeneration conditions, and to conduct burns without harming soil nutrients or leading to soil erosion. Some residue burning is keyed to detract as little as possible from natural beauty and to minimize pollution from burning and the threat of wildfire. There is much to be gained from expanding these current pilot burning techniques to broader areas.

Crop residues

Crop residues may sometimes be considered a beneficial resource rather than a pollutant. Much effort has gone into improving machinery for processing stalk and crop residues so they can be left on the surface. Improved seedbed preparation and planting machinery have reduced planting problems associated with crop residues. The control of wind and water erosion is enhanced by crop residues on the surface.

Microbial decomposition of crop residue is accompanied by great changes in the microbial populations in the soil. There is ample evidence that plant pathogens are sometimes suppressed or eliminated during this surge of microbial activity. If the basis for this biological control of disease organisms were known so that the residue could be treated or amended to augment this response, it would be one of the most important breakthroughs in soil microbiology.

It is also known that certain decomposing crop residues have a toxic effect on subsequent crops, particularly in the seedling stage. Detailed knowledge of the chemistry and biological effects of residue decomposition may reveal many unsuspected harmful or beneficial effects on crop growth. Eventually, it may be possible to manage the decomposition of crop residue, not only to reduce harmful effects but even to stimulate crop response. There is need for encouraging and promoting known residue-management practices that minimize pollution of the environment.

III. Areas of Emphasis

The following areas require emphasis in meeting the problem of pollution by forest and crop residues.

1. Minimizing production of undesirable forest and crop wastes

In the Department of Agriculture research is being directed to developing crops that produce a minimum of residues such as short-stalk small grains including wheat, oats, and corn. Research will continue on improving cropping sequences that contribute to insect and disease control and that systemically dispose of previous crop residue by tillage for succeeding crops.

Forest residue caused by forest fires will be reduced by a strong action and research program to reduce the area burned. Action programs in the Department are directed to preventing as many fires as possible, discovering fires promptly, and taking fast aggressive action to control them at small size. Stronger ground and air forces are needed and will be applied as funds become available. Fuels need to be made less flammable with modification and breaks. Research is directed to new equipment and techniques to do these things better and more efficiently.

The Department of the Interior interest lies in keeping residues in forests under its jurisdiction to a minimum in regard to forest fires and for public recreation.

2. Improving utilization of forest and crop residues

The Department of Agriculture's programs in forest areas are directed to more fully utilizing trees and other growth for useful purposes. Pulp operations are taking much smaller material than formerly. Prelogging and postlogging operations are taking out material formerly left in the forest that added to the fire hazard. New equipment and techniques are under development to increase this utilization. Research is now directed and more is planned to utilize crop residues in cellulose and chemical conversions such as in paper manufacture. Much supplemented crop residue is utilized for animal feed. Further progress in this area will reduce residue accumulation and the need for burning. Progress continues in developing equipment and procedures for utilizing crop residues as mulch. This contributes to the control of wind and water erosion.

The Department of the Interior has no program in this area.

3. Treating or removing hazardous or excessive forest and crop residues in the environment

The Department of Agriculture is developing improved techniques and planning additional research on procedures for doing a more efficient job of burning and at the same time reducing air pollution from smoke. Some burning of crop stubble continues, but this is minor and is being reduced. Action and research programs are directed to using this residue for useful purposes.

The problem of pollution from forest and crop residues is being studied by the Department of the Interior to determine the effects on water quality.

4. Assisting local areas in developing guidelines and control programs to govern the disposal of forest and crop residues

Cooperative forest programs of the Department of Agriculture in fire control and timber management assist local jurisdictions with slash burning. The cooperative management program assists local timber operators to better utilize their timber, which means less residue left in the woods. Extension and education programs assist local areas in converting crop residues to mulch to lessen wind and water erosion. The Department plans to continue its emphasis on assisting and encouraging local areas to adopt improved procedures for residue disposal or utilization as such procedures are developed.

The Department of the Interior has no program in this area.

FOREST AND CROP RESIDUES

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from forest and crop residues. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

Minimizing production of undesirable forest and crop wastes

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.40	.51	.55	.60	.65	.70	.76	3.26
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	3.80	3.80	6.40	6.50	6.70	6.90	7.20	33.70
DHEW	--	--	--	--	--	--	--	--
USDI	.25	.25	.25	.25	.25	.25	.25	1.25
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Improving utilization of forest and crop residues

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.66	.67	.72	.77	.80	.90	.95	4.14
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	2.21	2.29	2.73	2.68	2.63	2.63	2.63	13.30
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	1.00	.50	2.50	3.50	4.50	5.00	5.00	20.50
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Treating or removing hazardous or excessive forest and crop residues in the environment

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.13	.13	.15	.17	.19	.20	.25	0.96
DHEW	--	--	--	--	--	--	--	--
USDI	.01	--	.05	.10	.10	.05	.05	0.35
Action								
USDA	15.62	15.62	17.75	17.80	17.85	17.94	17.97	89.31
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	1.00	.50	2.50	3.50	4.50	5.00	5.00	20.50
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Assisting local areas in developing guidelines and control programs to govern the disposal of forest and crop residues

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.10	.10	.10	.10	.10	.10	.16	.56
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	2.60	2.60	4.20	4.35	4.60	4.65	4.80	22.60
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	2.50	2.70	2.80	3.00	3.10	14.10
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Department and Legislation	Minimizing lines and crop w					Total					
	Research and Development			Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	19	69	5-year	1969	5-year	1969	5-year	1969	5-year
USDA											
Existing	.51	3.26	3	--	--	1.41	8.92	24.31	158.91	.10	41.00
Proposed	--	--		--	--	--	--	--	14.10	--	--
DHEW											
Existing	--	--		--	--	--	--	--	--	--	--
Proposed	--	--		--	--	--	--	--	--	--	--
USDI											
Existing	--	--		--	--	--	.35	.25	1.25	--	--
Proposed	--	--		--	--	--	--	--	--	--	--
TOTAL											
Existing	.51	3.26	4	--	--	1.41	9.27	24.56	160.16	.10	41.00
Proposed	--	--		--	--	--	--	--	14.10	--	--

1/ See tables for the individual Areas of

Department and Legislation	Areas of Emphasis--Estimated Funding 1/																											
	Minimizing undesirable forest and crop wastes						Improving utilization of forest and crop residues						Treating or removing forest and crop residues in the environment						Assisting in developing guidelines and control programs						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																											
USDA																												
Existing	.51	3.26	3.80	33.70	--	--	.67	4.14	2.29	13.30	.05	20.50	.13	.96	15.62	89.31	.05	20.50	.10	.56	2.60	22.60	--	--	1.41	8.92	24.31	158.91	.10	41.00
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.10	--	--	--	--	--	14.10	--	--
DHEW																												
Existing	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																												
Existing	--	--	.25	1.25	--	--	--	--	--	--	--	--	--	.35	--	--	--	--	--	--	--	--	--	--	--	.35	.25	1.25	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																												
Existing	.51	3.26	4.05	34.95	--	--	.67	4.14	2.29	13.30	.05	20.50	.13	1.31	15.62	89.31	.05	20.50	.10	.56	2.60	22.60	--	--	1.41	9.27	24.56	160.16	.10	41.00
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.10	--	--	--	--	--	14.10	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

INORGANIC SALTS AND MINERALS

I. The Problem

All streams contain dissolved inorganic salts and minerals from natural sources as well as from commercial activities. Inorganic salts and minerals include salts, metals, metallic compounds, acids, and alkalis.

Though the presence of dissolved salts and minerals in waters is universal, their presence in detrimental concentrations is generally associated with part of the irrigated cropland in arid regions of the country and not with the relatively humid East. The concentration of these materials not only affects such agricultural activities but also the treatment required for making water suitable for drinking and for industrial use.

Salinity from natural sources stems mainly from the saline characteristics of soils and from the geologic formations from which the soils are formed. The salts have not been leached out because of the scarcity of precipitation. In other areas salt beds or saline strata of geologic origin may be primary contributory sources, finding their way into water sources through leaching and runoff. In some coastal areas salinity can be caused by flooding or other intrusion from the sea or brackish backwaters.

In agricultural operations in the arid part of the nation, water is supplied to crops in the necessary quantities to sustain growth. Concentration of the salts occurs in the soil as a result of water loss through evaporation and transpiration. Waters are also polluted by inefficient and excessive use of irrigation water which picks up salts, fertilizers, and minerals in the soil layers and underlying strata as it returns to the streams for reuse.

Where the salt content of the water and soil can become excessive it is necessary to maintain a favorable salt balance if irrigated crops are to survive. The salt balance is a function of many aspects of the soil and crop. To maintain a tolerable level of salinity in the soil that will support crop growth, all or almost all of the salt brought to the soil by irrigation water must be leached out by drainage water. Since the volume of drainage water is much less than the irrigation water applied, the salt content in the drainage water is much greater. For example, in the lower Colorado River Basin, the salt content of irrigation water is such that 6 tons of salt per acre are applied with the 5 acre-feet of water used to produce a crop. Consequently, at least 6 tons of salt per acre must be removed in the drainage water to maintain a level of soil salinity suitable for crop growth. As the drainage

water finds its way back into the river, the salt concentration of the river increases. Repeated use of the source water in this manner increases the salt concentration of the water to the level where it eventually can become unsuitable for further use.

It should also be pointed out that, along with an increase in salt content, changes in relative ion content may also occur. High ratios of sodium to divalent cations are detrimental to irrigated land. Very often this ratio tends to increase as a result of irrigation return flows, depending on the salt composition and concentration in the irrigation water and in the soil.

Furthermore, some waters may contain ions such as chloride and bicarbonate that are, except at very low concentrations, specifically toxic to certain crops.

In addition to the effects of gross quantities of salts, specific minerals, including the heavy metals, can have detrimental effects on agricultural, industrial, and domestic uses of water. Boron, though necessary in trace amounts, is detrimental to many plants when concentrations exceed 2 milligrams per liter. Chlorides and sulfates in excess of 250 and 500 milligrams per liter respectively affect the taste of water. When magnesium sulfate is in excess of 400 milligrams per liter, laxative effects can generally be expected.

Other elements that are toxic to plants and animals may exist in natural waters. For example, arsenic seems to limit the uptake of zinc by plants. Fluoride in small amounts in water is beneficial to the teeth but in excessive amounts may cause damage to the teeth and bones of animals and people.

Other man-made pollution problems relate to pesticide and fertilizer production and application. The inorganic elements in the various materials may accumulate in the soils and subsequently be injurious to living things. These may be adsorbed by the soil and be leached or eroded off into receiving waters. In addition waste from the production of pesticides and fertilizers may enter bodies of water.

II. Methods and Effects of Control

Salt concentration in source waters can be decreased by a variety of methods that have been or can be developed. Diversion of water with high salt concentrations to less critical areas as well as plugging or water treatment can reduce the severity of the problem. Management of flows from reservoirs can be utilized for mixing and diluting water from various sources to obtain irrigation water of suitable quality.

Evaporation from reservoirs and evapotranspiration from canals and watersheds can be reduced by various means. This reduction increases the available water supply but not the total salt. The result is a lower salt concentration in the water. Opportunities also exist for increasing water yields through scientific management practices on source watersheds. Such increases can serve to dilute salt concentrations in irrigation water.

Improved irrigation-management practices can reduce the excessive amounts of water used. This decreases the salt burden in the water and provides a more favorable salt balance during the growing season. For example, improvement of irrigation practices gives better control of the amount of the irrigation water that is passed through the soil and leaching requirements can be more efficiently met. Improvement of drainage also reduces the salt concentrations in the soil. These two practices, while reducing or preventing a buildup of the salt in the soil, paradoxically increase the salt content of the return flow to the basic water supply. Studies of methods to reduce evapotranspiration from irrigated fields also offer promise of reducing consumptive use of water and hence the accumulation of salt.

Return flows inevitably have a much higher concentration of salts than the irrigation water. If these are returned to the stream, salt concentrations in the stream are increased. Diversion of return flows can keep the salts out of the streams, but it also reduces the amount of water downstream that is available for other uses. Additional methods of treatment are needed to remove salts from irrigation water.

Although emphasis should be placed on preventing the degradation of soil and water by excessive concentrations of salts or minerals, this approach is not always feasible. Increased plant tolerance to salinity, alkalinity, or metals may be a logical alternative. Much remains to be learned about the mechanism of damage to plants from inorganic salts and minerals. Breeding for tolerance will reduce this damage and will be more efficient when the mechanism of the damage is better understood.

III. Areas of Emphasis

The following areas encompass the major approaches useful in reducing pollution caused by inorganic salts and minerals.

1. Decreasing salt concentration of the irrigation supply source

The Department of Agriculture has both research and action programs underway to increase water yields through reduction of evapotranspiration and the more effective capture of precipitation.

Research also is underway on the control of seepage and evaporation from reservoirs and on management of waters of varying quality by practices such as mixing to keep the salt concentration in the most favorable balance during the irrigation season.

Extension programs to increase public awareness of the problems and potential solutions are underway in the 11 Western States.

The Department of the Interior, by virtue of various congressional acts, has responsibility to plan and develop supplemental water supplies to increase the quality of the resultant water supply system.

The Clean Water Restoration Act of 1966 gives USDI the responsibility for establishing water-quality standards for all water uses, including agricultural requirements. As such, USDI provides both direct technical assistance and comprehensive regional planning to effect the best quality of available water resources. It also provides impoundment and distribution resources to augment local supplies for irrigation waters and to enhance the quality of these water supplies. In addition, it has an extensive program for the removal of salts from supply waters that are applicable to agricultural uses.

2. Improving irrigation and drainage practices to minimize the effects of salts and minerals on soils and return-water quality

Department of Agriculture action programs include assistance to soil conservation districts to increase water-use efficiency by proper irrigation design and operation. Practices such as levelling and changing the length of irrigation runs are commonly needed to reduce salt concentration in the rooting zone and to reduce excessive water application. Over-irrigation commonly is the result of poorly designed distribution systems and improper irrigation practices.

Extension education is underway in the fields of agronomy, horticulture, and agricultural engineering to acquaint the public with the problems and methods for meeting them. Loans are made to finance drainage and improve irrigation systems.

USDA also conducts research on practices to increase water-use efficiency and minimize salt accumulation. It has research programs underway to study the effects of salinity on the soils, leaching requirements, effects of heavy metals and trace elements, critical water-use periods during plant development and fruiting, nutrient requirements under irrigation, water intake and transmission qualities of soils, indicators of when to apply water, automation of water application, irrigation scheduling, drainage materials and system design criteria, plant aeration requirements, methods to prevent tile clogging by mineral oxides and sediment, and methods to improve water flow to and into tile systems.

The Department of the Interior has an intensive program to develop optimal irrigation practices for those regimes that are supplied through the Bureau of Reclamation's programs.

3. Treating or disposing of salts and minerals in return flows

The Department of Agriculture considers its authority adequate for research in this field but inadequate for action programs.

Research is needed on the use of salt sinks where salty water is impounded and evaporated by solar energy, on injection systems for disposal of highly concentrated salt water into underground cavaties where ground water would not be contaminated (areas from which crude oil has been pumped, coal mined, etc.), and on open or closed conduit systems for conveyance to inland salt sinks or to the ocean.

The only action program underway is a field evaluation of current programs of other agencies.

Under proposed authority, USDA would install 5 to 10 pilot systems to test methods of reducing salinity by control of return flows. The present theory needs to be tested before widespread action programs are started.

The Department of the Interior has extensive programs for the removal of gross quantities of salts from brackish water or from return flows as well as for the removal of municipal, industrial, or special pollutants, such as acid mine drainage. In addition, it has initiated projects to remove specific contaminants such as boron by either membrane or ion-exchange techniques.

Deep-well injection of brine-laden waters is standard practice in oil production and is used extensively for the disposal of noxious industrial plant effluents. These methods are also applicable to the disposal of treated agricultural effluents. The problems associated with deep-well disposal are part of an overall program in USDI.

4. Improving plant tolerance and utilization of salts and minerals

The Department of Agriculture has research underway on the tolerance and physiological reactions of plants to salinity, the breeding of plants for both salt tolerance and reduced transpiration, the use of grafting techniques to provide salt-tolerant fruit crops, and the determination of toxicity levels and nutritional needs of the plant for specific ions. Closely related is research on the relation of salinity to condition and transport of water and ions in soils and plants.

INORGANIC SALTS AND MINERALS

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from inorganic salts and minerals. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

DHEW figures for plant nutrients include some funds expended on inorganic salts and minerals.

The entire USDI program concerned with distillation and membrane technology can be applied directly to the problem of decreasing the salt concentration of irrigation water. In addition, the water-flooding and brine-disposal operations conducted by the Department are directly applicable. Neither of these activities is included.

Decreasing salt concentration of the irrigation supply source

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.15	.25	.30	.30	.40	.40	.60	2.00
DHEW	--	--	--	--	--	--	--	--
USDI	.35	.36	.80	1.15	1.55	1.55	1.55	6.60
Action								
USDA	.12	.22	.22	.52	.73	.93	1.23	3.63
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Improving irrigation and drainage practices to minimize the effects of salts and minerals on soils and return-water quality

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.70	.63	.90	1.21	1.30	1.54	1.65	6.60
DHEW	--	--	--	--	--	--	--	--
USDI	.43	.45	1.03	1.55	1.85	1.85	1.85	8.13
Action								
USDA	1.30	1.31	1.63	1.96	2.41	3.43	3.64	13.07
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	15.00	14.00	20.00	25.00	30.00	35.00	35.00	145.00
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Treating or disposing of salts and minerals in return flows

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	--	.14	.24	.32	.43	.47	.50	1.96
DHEW	--	--	--	--	--	--	--	--
USDI	.83	.93	1.05	2.08	1.60	1.60	1.10	7.43
Action								
USDA	.10	.10	.19	.19	.19	.19	.19	.95
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	.40	.50	1.00	2.00	4.00	7.90
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Improving plant tolerance and utilization of salts and minerals

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.20	.20	.45	.53	.58	.62	.65	2.83
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--
Proposed Legislation								
Research and Development	--	--	--	--	--	--	--	--
Action								
USDA	--	--	--	--	--	--	--	--
DHEW	--	--	--	--	--	--	--	--
USDI	--	--	--	--	--	--	--	--
Loan Level								
USDA	--	--	--	--	--	--	--	--

Department and Legislation	Decreasing sal and the irrigation			inerals		Total					
	Research and Development		Ac	Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	1969	5-year	1969	5-year	1969	5-year	1969	5-year
U S D A											
E x i s t i n g	.25	2.00	.2	--	--	1.22	13.39	1.63	17.65	14.00	145.00
P r o p o s e d	--	--	--	--	--	--	--	--	7.90	--	--
D H E W											
E x i s t i n g	--	--	--	--	--	--	--	--	--	--	--
P r o p o s e d	--	--	--	--	--	--	--	--	--	--	--
U S D I											
E x i s t i n g	.36	6.60	--	--	--	1.74	22.16	--	--	--	--
P r o p o s e d	--	--	--	--	--	--	--	--	--	--	--
T O T A L											
E x i s t i n g	.61	8.60	.2	--	--	2.96	35.55	1.63	17.65	14.00	145.00
P r o p o s e d	--	--	--	--	--	--	--	--	7.90	--	--

1/ See tables for the individual Areas of

Department and Legislation	Areas of Emphasis--Estimated Funding 1/																											
	Decreasing salt concentration of the irrigation supply source						Improving irrigation and drainage practices						Treating or disposing of salts and minerals in return flows						Improving plant tolerance and utilization of salts and minerals						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																											
USDA																												
Existing	.25	2.00	.22	3.63	--	--	.63	6.60	1.31	13.07	14.00	145.00	.14	1.96	.10	.95	--	--	.20	2.83	--	--	--	--	1.22	13.39	1.63	17.65	14.00	145.00
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.90	--	--	--	--	--	--	--	--	--	--	--	7.90	--	--
DHEW																												
Existing	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																												
Existing	.36	6.60	--	--	--	--	.45	8.13	--	--	--	--	.93	7.43	--	--	--	--	--	--	--	--	--	--	1.74	22.16	--	--	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																												
Existing	.61	8.60	.22	3.63	--	--	1.08	14.73	1.31	13.07	14.00	145.00	1.07	9.39	.10	.95	--	--	.20	2.83	--	--	--	--	2.96	35.55	1.63	17.65	14.00	145.00
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.90	--	--	--	--	--	--	--	--	--	--	--	7.90	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

PESTICIDES IN THE ENVIRONMENT

I. The Problem

Pest control has made possible the production of an increasing amount of food of superior quality and, combined with fertilizers and improved cultural techniques, has made a significant contribution to the American and world standard of living. Pest control has also freed us from a host of insect-borne diseases and permitted more pleasant and healthful utilization of our environment.

The use of chemical pesticides, particularly synthetic organic materials, has increased rapidly in the last two decades. These pesticides become pollutants when they, their metabolites, or their degradation products remain in the environment after the desired purpose has been accomplished or when they reach some part of the environment other than the intended target. Pesticides vary in the amount of pollution they produce, depending on their persistence, for example, short-lived pesticides such as tetraethyl pyrophosphate rapidly break down into relatively harmless compounds, but materials such as DDT degrade less rapidly and are metabolized into other toxic compounds (DDE and TDE).

Coupled with the degree of pollution is the relative severity of the pollutant in the environment. A persistent pesticide such as elemental sulfur (80 percent of the fungicide used in 1964) with a very low mammalian toxicity is a better short-time environmental risk than a much less persistent organo-phosphorus pesticide with a very high mammalian toxicity.

From the long-term environmental-risk standpoint sulfur may be less desirable. The problem of pollution by pesticides is complex.

Not only are pesticides used against a wide variety of organisms, ranging from viruses and bacteria to coyotes and birds, but they include an equally wide range of chemical structures from phosphorus paste to highly complex plant products such as rotenone and pyrethrins. They include materials that are commonly used for other purposes such as sulfur, petroleum oil, and carbon tetrachloride, and they include highly specific materials such as DDT, synthesized only for their use as pesticides. They include transient compounds such as tetraethyl pyrophosphate, which rapidly hydrolyzes to innocuous materials in the presence of small amounts of moisture, to such highly stable compounds as lead arsenate. They include materials of very low mammalian toxicity such as silica gel or sulfur to such universal poisons as sodium arsenite, which is highly toxic to higher forms of plant and animal life.

The means of introducing pesticides into the environment can be divided into two broad categories.

Intentional

1. Agricultural and forestry uses
2. Aquatic uses for controlling insects, weeds, trash fish, etc.
3. Household and garden uses
4. Municipal and industrial uses
5. Public health uses

Unintentional or accidental

1. Accidents in manufacture, handling, transportation, storage, and use
2. Industrial and municipal wastes
3. Agricultural wastes such as crop residues, food-industry wastes, etc.
4. Drift from applications or movement by attachment to soil particles, etc.
5. Fires, floods, etc.

Pesticides are used for many purposes in addition to protecting crops and livestock from insects, diseases, weeds, and other pests, for example, water sources are treated to control weeds, mosquitoes, trash fish, etc. Pest birds and predatory animals are controlled by properly applied pesticides.

They are also used to control parasites and vectors of diseases of public-health importance.

Release and distribution of pesticides may occur during manufacture, handling, transportation, storage, or use. Although reported accidents have been relatively few some have resulted in high local concentrations of pesticides in the environment. We know a great deal about the fate of many registered pesticide chemicals, but we know very little about the nature and fate of the many products in wastes from pesticide manufacture. Large tonnages of these materials are buried in "dumps" and may enter our waters and soils for many years.

Agricultural byproducts and wastes also constitute a major source from which pesticides enter the environment. Almost all agricultural byproducts and wastes contain small amounts of pesticides, the levels usually being low enough to permit their use without danger to public health. For the exceptions, registration is based on prohibiting use of the byproducts as human or animal food.

Inadvertent or accidental contamination of the environment may occur during and after application of pesticides to crops and forests by several routes. Inadvertent application to streams and ponds or to land areas not intended to be treated has occurred. This source of contamination can be minimized but not completely eliminated. Air drift often occurs, particularly if application is by aircraft. Also drift from other types of application, even under the most favorable meteorological conditions, must not be underestimated. Although this undesirable situation can be minimized by careful application, a certain amount of drift is unavoidable.

Movement by air currents is a potential source of contamination that is not well understood and needs careful study. Drift of sprays and dusts over relatively short distances is recognized. There are good indications that substantial amounts of pesticides volatilize after application and may be transported for considerable distances.

Erosion resulting from heavy rains or from irrigation is a source of pesticide movement from treated to untreated areas, into ponds, and into both surface and underground waters. Sorbed pesticides are carried with the soil particles, sometimes for considerable distances, and deposited in the beds of streams, in ponds and lakes, and on land subject to flooding. In addition, according to some investigators, minute amounts are carried in solution in the water, particularly in soil water.

Minute amounts of pesticides occur in our food supply as a direct result of agricultural use. Market-basket surveys have shown that the amounts of pesticide chemicals in a high-consumption diet are well below the acceptable daily intake established by the World Health Organization Expert Committee (WHO), except for aldrin and dieldrin. The calculated daily intake for these compounds from this high-level diet is approximately equivalent to the WHO-established acceptable daily intake. It is significant that foods of animal origin--dairy products, meat, fish, eggs and poultry--are the major source of the dietary intake of chlorinated organic pesticides. Very few sanctioned uses are known to result in residues of the pesticides most commonly found in these foods.

In addition to the market-basket study, a surveillance program is conducted in which 25,000 samples of agricultural commodities are collected annually and analyzed for pesticide residues. In general, during the past 4 years, about one-half of the samples contained residues of one or more pesticide chemicals. About 3 percent were found to exceed established tolerances or, in the absence of established tolerances, administrative guidelines for excessive residues. More than 75 percent of the individual residues were less than 0.11 ppm, and 95 percent of the residues were less than 0.51 ppm. This general pattern was observed when the data were considered by specific chemicals, by food category, by domestic or imported products, or on an annual basis.

The general pattern of pesticide residues in meats agrees with the pattern found in these surveillance programs.

Varying levels of pesticides have been reported in some wildlife. A number of studies have been made on wildlife in areas treated with pesticides. Accumulations of pesticides have been demonstrated and evidence indicates that there may be harmful physiological effects. Additional studies have been reported on controlled feeding experiments. In these studies, rate of deposition, metabolism, and in some studies acute or chronic toxicity patterns were determined. Reports of residues of DDT and related compounds in animals from remote areas are of special interest.

Where aquatic life is concerned, an entirely different situation may exist. Certain lower forms in aquatic food chains may accumulate the chlorinated hydrocarbon pesticides present in the water in almost infinitesimal amounts. Fish that use these microfauna and microflora as a major source of food may accumulate high levels of certain pesticides or their metabolites in their fat.

Oysters are particularly efficient in extracting DDT from the water. Many smaller organisms in addition to plankton, shrimp, and oysters possess this same ability to concentrate certain chemicals. To a lesser extent a similar concentration may occur in certain birds and animals.

Doubtless the most important problem regarding pesticides as environmental contaminants is an evaluation of their long-term ecological significance. The ubiquity of certain persistent pesticides has been well established. The levels found have been below known toxic levels for the most part. Current knowledge as to whether these levels are rising or not is inadequate.

The analytical methodology being used to determine residue levels in most substrates is being rapidly developed. Existing data require careful scrutiny to insure reliability.

The overall use of synthetic organic pesticides is increasing rapidly. On the other hand a significant decrease has occurred in some areas, such as using pesticides for controlling forest pests.

The domestic consumption of DDT (still the most important single insecticide) is in general decline (from 78.6 million pounds in 1958-59 to 52.9 million pounds in 1964-65). On the other hand, use of the more toxic aldrin-toxaphene group (includes six related compounds) rose from 34 million pounds in 1953 to about 80 million pounds in 1961. Even though these chlorinated hydrocarbons are chemically very stable, all of them can be degraded in one way or another and it is not sound to assume that

their continued use necessarily means a continued build-up in levels. It is now well established that the level of DDT storage in human fat reaches a plateau in about 6 months and that continued intake at a constant level does not increase the storage level.

The second aspect of this problem is the question of whether long-term exposure to sublethal levels of pesticides may produce ecological changes that are not apparent immediately. Such changes may be either genetic changes over many generations or creation of environmental problems that affect man's welfare. There are evidences of both types of effects. In the first, development of inherently resistant target species is well documented.

Soils may carry high residues of persistent pesticides for many years. These residues in turn have contaminated soil organisms and found their way into the food chain. Contaminated soils may erode into water supplies and provide pollution.

Most of the major water courses of the Nation carry some levels of persistent pesticides. The extent of this pollution, the trend in severity, and the probable effect on aquatic resources are generally unknown. More significant may be pollution of the lakes and estuaries into which these rivers empty. The potential for adverse influence on lake fish or shrimp and other aquatic life of the estuaries is a factor that should be assessed as precisely as possible. The third aspect is air pollution, and pesticides may add significantly to the already serious problem.

Another related problem is the significance of immediate toxic effects of pesticides. It has been charged recently that the pressure to avoid persistent chlorinated hydrocarbon insecticides has resulted in greater damage because of use of more toxic but less persistent substitutes. Two examples occurred in 1967 in the Southwest. The use of the organic phosphorus insecticide Azodrin in controlling the cotton bollworm killed large numbers of doves and related birds. Probably DDT or toxaphene would have resulted in less direct kill. In the other example a carbamate insecticide, carbaryl, is relatively nonpersistent and has low toxicity to vertebrates. But it is very toxic to bees, and there have been charges that its use has wiped out many apiaries with resultant damage to pollination of crops and other plants. Other more subtle immediate effects include the decimation of natural enemies of pests and the destruction of food organisms for beneficial fish and wildlife.

Another major problem is the disposal of pesticidal wastes without contaminating the environment. The sources of such wastes range from disposal of large concentrations of industrial wastes to the widely dispersed discarded containers that usually carry heavy residues. The difficulty is that there is considerable interest in the problem but a great paucity of ideas as to practical solutions.

II. Methods and Effects of Control

Improved knowledge of the fate of pesticides in the environment will be useful in resolving the controversies surrounding the use of these chemicals.

Extensive pesticide-research programs are underway that are related to the pollution aspects of pesticides. The Committee on Environmental Quality of the Federal Council of Science and Technology has developed the figures shown in table 3 on the Federal effort in this area.

TABLE 3.--Federal expenditures for pesticide-related research in FY 1967

	USDA	DOD	DHEW	USDI	STATE	AEC	NSF	TVA	Total
	(millions of dollars)								
Effects of pollution----	1.75	---	5.19	1.35	---	---	0.19	0.01	8.49
Transport, distribution, and fate of pollutants---	6.11	---	3.86	.95	---	0.06	---	---	10.98
Measurement and instrumentation---------	.65	---	2.21	.35	---	---	---	---	3.21
Prevention and control of pollution----	37.46	0.62	2.53	1.41	0.48	.35	.30	.04	43.19
Total------	45.97	0.62	13.79	4.06	0.48	0.41	0.49	0.05	65.87

The extent to which a pesticide represents a significant pollutant is measured by the impact of the particular chemical on all components of the environment. An extensive effort is underway to determine the effects of specific pesticides on the environment, particularly with regard to man and beneficial organisms, e.g., insects, fish, wildlife, etc. A systems approach is desirable because of the interactions between pesticides and other environmental contaminants and because there is movement of pesticides and their degradation products between soil, air, and water.

The nature and extent of pesticides in the environment is being determined by several monitoring programs of the Federal Government. These programs are being coordinated by the Monitoring Subcommittee of the Federal Committee on Pest Control.

Federal agencies, universities, and industry also have been conducting research on the chemical changes that take place in organic pesticides in the environment and on the toxicity of the intermediate and end products. In some cases a metabolite has been shown to be significantly more toxic than the original pesticide. On the other hand, most end products are less toxic. A better understanding of the rate and manner of such degradation under different environmental conditions would provide a useful basis for determining the conditions under which specific chemicals should be used.

There also are opportunities for reducing the quantity of hazardous pesticides that are introduced into the environment.

The development of integrated control programs involving the combined use of chemical, cultural, physical, and biological methods has progressed to the point where area pest-suppression programs appear feasible for several economically important insects. These programs have progressed through laboratory and limited field evaluations. In some cases, large-scale (thousands of acres) field applications of this technique are required. Further development of integrated control programs would greatly reduce the use of chemical pesticides.

Other opportunities to reduce the amount of hazardous pesticides introduced into the environment include application of chemicals only when required; substitution of less dangerous, readily degraded materials; and such approaches as improved erosion control to prevent the movement of pesticides from land to water.

Research has demonstrated that the addition of materials such as charcoal to soil containing pesticides has been effective in reducing the amount of residues that leave treated areas in runoff. But utilization of this technique is questionable from both the cost standpoint and the effect the charcoal will have on subsequent applications of pesticides.

Probably significant amounts of pesticides are transported in air from their place of application as a result of drift during application and by volatilization following treatment. This movement may be the principal method of dispersion over wide areas. Examination of this may result in development of the means to prevent its occurrence.

"Empty" pesticide containers add to pollution of the environment. It is estimated that several million containers are used annually. At present, recommendations for their disposal call for burial in an area where ground or surface water will not be contaminated. This recommendation is not adequate to provide the required protection of the environment.

Decontamination or destruction of "empty" containers as well as protection of persons handling them are major problems. Safe removal of

residual pesticides from the environment is only part of the problem. Removal of a large number of unattractive containers would also be desirable.

Current research on container disposal is very limited. There is need to develop means to safely recycle these containers. Results of this program would have application in other container problems. The problem of industrial pesticide-waste disposal is also worthy of serious consideration. Development of an adequate incinerator or a method of chemical decontamination warrants immediate attention. The industrial waste and the "empty" container problems are closely associated. The solution to one may well assist in solving the other.

III. Areas of Emphasis

The following areas warrant major attention.

1. Evaluating the nature, extent, significance, and impact of pesticides in the ecosystem

In the Department of Agriculture, research is being directed toward the study of the biology, ecology, life history, physiology, morphology, taxonomy, nutrition, metabolism, habits, and behavior of target and nontarget organisms. The effect of pesticides on field populations, including measurement of immediate mortality, long-term effects on reproduction and survival, and the effects of species composition and density are also encompassed in present and projected research efforts.

Information gained from these studies assists in determining the nature, extent, significance, and impact of pesticides in the ecosystem.

USDA participates in the National Monitoring Program of the Federal Committee on Pest Control. Extensive long-range programs of soil monitoring are planned and limited parts of these programs are underway. Spot checking in suspected trouble spots will be continued. In addition, application of pesticides to forests and rangeland is monitored to determine the impact of these programs on the environment. These monitoring programs are a built-in part of the pest-control activities of the Department.

USDA also conducts a pesticide-monitoring program in federally inspected meat-packing plants.

In the Department of Health, Education, and Welfare, programs are underway to--

> Study medically and biochemically groups of people who are in contact with pesticides and other chemicals over a period of years to determine what effects chronic and acute exposure may have on the health of these people
>
> Maintain current information on the pesticide-use patterns in study areas to include changes in types of products, new compounds, and in amounts used and methods of application
>
> Continue monitoring of pesticide residues and their products in human tissues of the general population

Continue assisting State health departments in the maintenance of epidemiological and biochemical competence in diagnosis of pesticide effects upon man

Develop and improve methods for direct measurement of exposure of agricultural products, agricultural personnel, and other workers to pesticides, and an assessment of this exposure for potential toxicological problems

Present investigations encompass programs of toxicology and chemistry of chlorinated hydrocarbons, organophosphate insecticides, carbamates, and herbicides, in order to ascertain the public health hazards associated with their use.

Pharmacologic studies are directed toward investigation of the physiological and biochemical mechanisms involved in the transportation, detoxification, and metabolism of pesticides. Particular emphasis is applied to the effects of low-level long-term exposure. Included will be studies of the mode of transport, binding factors, metabolism in human as well as experimental animals, correlation of blood and brain levels of pesticides to illness or other effects of pesticide ingestion.

Long-term chronic toxicity studies in animals with emphasis on teratogenic defects are underway. Relationship of the dosage that produces an effect in animals will be considered with respect to possible exposure of man.

The long-term goal of these studies is to find a more adequate way to measure hazards to public health rather than to observe gross symptoms such as death.

Chemical research on pesticide residues in foods emphasizes (1) establishing the chemical identity of the residue, including significant conversion products; (2) developing, improving, and validating methodology for measuring the amount of such residue; and (3) occasional checking on the validity of data submitted in petitions.

Biological research emphasizes (1) studying physiological effects and metabolism of pesticides in biological systems, including the metabolic fate of the compounds, their biochemical reactions, the nature of the metabolic pathways, and an evaluation of their effects in terms of toxic action; (2) performing toxicity studies of pesticides as a method for determining safe tolerance levels; and (3) developing data on the direct effect of pesticides on man.

Surveillance and monitoring programs are established and maintained to determine the extent, trends, and significance of pesticide contamination of the national food supply. In part, these programs support the

National Pesticides Monitoring Program and are in collaboration with other agencies--Federal, State, and international--concerned with the use of pesticides and the effects of such use.

The Department of the Interior has primary responsibility for investigation of the effects of pesticides, both acute and chronic, on fish and wildlife and their associated environments and also on water quality. It investigates the pathways traveled by pesticide residues from application to uptake to evaluate their possible behavioral and physiological effects on birds, mammals, fish, and shellfish, as well as the food chains of which they are a part, and water. In-house and grant-supported research and monitoring programs are conducted, using selected species as indicators for determining the degree of contamination and for devising safeguards that may be necessary. The Department is cooperating with the Federal Committee on Pest Control in the National Pesticide Monitoring Program to the extent that its study of pesticide residues blankets continental United States and is concerned with fish, shellfish, wildlife, and water quality.

2. Reducing the amount of hazardous pesticides in the environment

The major emphasis of the Department of Agriculture pesticide programs is in this direction. These programs encompass--

A. Developing and using less hazardous alternate chemical controls.

B. Developing and using better methods of application that require less material or that place the needed toxic material more accurately. For example, pesticides are applied in forests only when meteorological conditions are right. Helicopters are used for applications near streams.

C. Developing and using nonpesticidal means such as (1) resistant crops, (2) parasites or predators, (3) self-destruction techniques (sterilization, breaking of diapause, etc.), (4) improved cultural practices and combinations of these and other procedures.

D. Developing and carrying out a comprehensive information and education program to encourage the safe use of pesticides for protection of the user, the consumer of food and fiber products, as well as for the protection of fish, wildlife, soil, air, and water from pesticide pollution.

Results to date indicate strongly that integrated control programs involving certain combinations of chemical control plus self-destruction

techniques and improved cultural practices may, if applied to a wide area, drastically reduce the amount of chemicals required and eventually reduce the dependence on chemicals. These programs also provide attractive economical considerations.

There has been much publicity about the screw worm control program in the Southwest in which USDA participates. Plans are developing for extending the control area well south into Mexico. In this manner the length of the treated barrier will be considerably shortened with a consequent increase in control and a decrease in cost. A large-scale integrated control program is being established for the pink bollworm in the Southwest. The Department is considering large-scale field evaluations of other integrated programs for pest control. For example, a large-scale program to control the codling moth in apples appears to be feasible. The development and installation of such programs will be rather costly.

One approach to major integrated control programs could be the cooperative development of facilities and programs. USDA would cooperate with the particular agricultural segment involved, such as a local growers association or a national organization that has close local affiliations. Under such a program the research and action agencies of the Department could develop the field program, train the necessary local people, and eventually turn the program over to the segment of the industry involved while continuing to provide necessary technical assistance. This is an example of how field evaluation of large-scale programs might be undertaken.

The Department of Health, Education, and Welfare has a primary policy to minimize the amount of pesticides sanctioned for use. Tolerances in foods are established at safe levels no higher than that required in the production of food even though a higher level may be safe.

The Department of the Interior is interested in minimizing the use of herbicides in irrigation-water conveyance systems. Programs include studies to determine the minimum amount of herbicides that can be applied in water conveyances to control noxious-vegetation growth. In addition, studies are being conducted to determine the persistence of herbicides and pesticides following various rates of application.

3. Treating, controlling, or removing pesticides from soil, air, and receiving waters

The monitoring programs of the Department of Agriculture have indicated that pesticide residues are present in soil, air, and water. The major portion of the Department programs have been devoted to monitoring of soil. This information coupled with information obtained during research aimed at more basic knowledge of pesticides aids in developing means of

treating, controlling, or removing pesticides from the environment. To date limited progress has been made in treatment or removal of pesticide residues from air, soil, and water. Progress has been made in control of pesticides in soil, air, and water by substituting short-lived materials for more persistent pesticides. As technology progresses and greater emphasis is placed on environmental quality, it is anticipated that the time will come when educational programs and significant technical and financial assistance are directed toward such work.

In-depth training schools are conducted for applicators, dealers, producers, professional leaders, and key consumer and user groups as a part of the USDA effort under this heading.

The Department of Health, Education, and Welfare monitoring activities for pesticides in air may be considered as the necessary preliminary work not only for this area and area 2 but also for evaluating the impact of pesticide contamination of air on man's health. Available information is scanty and inadequate for this purpose. The scope and severity of the problem should be better defined before any action program is undertaken. Additional work is needed to define acute and long-term effects and the contribution of particulates and of other contaminants in air to the impact.

The Department of the Interior has major responsibility for the treatment, control, and removal of pesticides from the aquatic environment. The development of treatment methods for ameliorating and removing pesticides in water is extremely difficult. Several approaches are being actively pursued.

4. Disposing of pesticide wastes, including used pesticide containers, in a manner least detrimental to the environment

Efforts are being made by the Department of Agriculture to obtain a valid estimate of the number and sizes of "empty" pesticide containers and the amount of pesticide wastes that exist. Present programs in this area of emphasis are modestly funded. The major program consists of contract research to determine the combustion temperatures and products of a series of representative pesticides. Another part of this contract deals with the design of a low-cost incinerator for the destruction of pesticides.

The planned USDA programs consist of additional work, probably by contract, to develop similar information on other pesticides. Once a suitable design is developed for an incinerator and a demonstration model is constructed, tested, and proved, attention will be given to assisting in the construction and utilization of units at suitable locations.

The Department of Health, Education, and Welfare has responsibility for surveying methods currently used for the disposal of such wastes in the respective States. This preliminary information will aid definition of the scope of the problem and aid in the optimal location of future action programs.

The Department of the Interior has no program in this area.

5. Assisting State regulatory agencies in the establishment of uniform effective pesticide regulatory programs

The Department of Agriculture has assisted the Council of State Governments in developing uniform regulations in the form of a model law. This model law will be revised as needed. The Department will assist in this program.

USDA has cooperated with the State departments of agriculture in enforcing pesticide regulations. The Department does not enforce any State regulations but does participate in the exchange of information regarding enforcement activities within each State. Though the greatest effort may be completed, these programs will continue.

The Department of Health, Education, and Welfare promotes the adoption of uniform pesticide-residue legislation by the States; maintains an information system to the States whereby pesticide-residue tolerances, reports of seizures, prosecutions, and injunctions, and pesticide action-level guides, etc., are transmitted regularly to the States; transmits and maintains a Pesticide Analytical Manual for State regulatory analysis; answers inquiries from State officials concerning pesticide-residue problems; and on request offers technical assistance to the States in planning and developing State pesticide-residue programs. A partnership pesticide program with the States is now under consideration. This would permit the States to accept primary responsibility in the surveillance of pesticide residues at the grower level. Achieving full implementation of such a program will depend on FDA's obtaining authority to grant financial assistance to the States.

State and local chemists and other health personnel from throughout the country are trained in the latest techniques of chemical analysis and pesticides technology.

On request, State laws pertaining to labeling and safe use of pesticides (protection of applicators, condition of equipment, delivery of desired amounts and concentrations, and education of applicators on hazards of compounds) are reviewed as part of the State Pesticide Projects and by the Training and Consultation Unit. This work is usually performed in

connection with the State Health Department. In addition, a guideline law has been developed to serve as a uniform basis in evaluating State laws regulating professional applicators.

The Department of the Interior insures that proposed uses of new pesticide formulations will present the minimum hazard to fish and wildlife resources. The establishment of water-quality standards reflecting results of the research and development programs in this area are also of concern to the Department.

PESTICIDES IN THE ENVIRONMENT

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from pesticides. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

Evaluating the nature, extent, significance, and impact of pesticides in the ecosystem

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	12.98	13.00	13.00	13.05	13.10	13.20	13.20	65.55
DHEW	7.42	7.50	7.46	7.46	8.09	8.40	8.40	39.81
USDI	1.51	1.73	1.90	2.10	2.50	2.60	2.65	11.75
Action								
USDA	.76	.76	3.01	3.41	3.41	3.41	3.41	16.65
DHEW	3.09	2.16	2.06	2.08	1.97	1.95	1.95	9.41
USDI	.62	.65	.62	.65	.75	.75	.83	3.60
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Reducing the amount of hazardous pesticides in the environment

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	28.00	28.18	28.18	28.20	28.20	28.20	28.20	140.98
DHEW	-	-	-	-	-	-	-	-
USDI	.10	.06	.14	.14	.17	.25	.25	.95
Action								
USDA	9.79	10.39	13.49	17.82	19.22	19.25	19.25	39.03
DHEW	.26	.22	.23	.24	.24	.24	.24	1.19
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Treating, controlling, or removing pesticides from soil, air, and receiving waters

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	4.60	4.62	4.65	4.65	4.70	4.70	4.70	23.40
DHEW	-	-	-	-	-	-	-	-
USDI	.28	.08	.20	.25	.25	.25	.25	1.20
Action								
USDA	2.65	2.65	2.65	2.65	2.65	2.65	2.65	13.25
DHEW 1/								
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

1/ Program expenses are less than $.01 million annually.

Disposing of pesticide wastes, including used pesticide containers, in a manner least detrimental to the environment

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.11	.11	.15	.20	.20	.20	.20	.95
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	.60	.60	.73	.73	.73	.73	.73	3.65
DHEW	.02	.02	.02	.02	.02	.02	.02	0.10
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Assisting State regulatory agencies in the establishment of uniform effective pesticide regulatory programs

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.03	.03	.05	.05	.05	.05	.05	.25
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	.57	.57	.57	.57	.57	.57	.57	2.85
DHEW	.06	.07	.07	.13	.13	.13	.13	0.59
USDI	.25	.25	.25	.25	.30	.40	.50	1.70
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Department and Legislat	Assisting State regulatory agencies in establishing regulatory programs					Total					
	ch and pment	Action		Loan Level		Research and Development		Action		Loan Level	
	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
USDA	.25	.57	2.85	--	--	45.94	231.13	14.97	75.43	--	--
Exist	--	--	--	--	--	--	--	--	--	--	--
Propo											
DHEW	--	.07	.59	--	--	7.50	39.81	2.47	11.29	--	--
Exist	--	--	--	--	--	--	--	--	--	--	--
Propo											
USDI	--	.25	1.70	--	--	1.87	13.90	.90	5.30	--	--
Exist	--	--	--	--	--	--	--	--	--	--	--
Propo											
TOTAL	.25	.89	5.14	--	--	55.31	284.84	18.34	92.02	--	--
Exist	--	--	--	--	--	--	--	--	--	--	--
Propo											

1/ See ta

2/ Progra

Areas of Emphasis--Estimated Funding 1/

Department and Legislation	Evaluating pesticides in the ecosystem						Reducing hazardous pesticides in the environment						Treating, controlling, or removing pesticides from soil, air, and receiving waters						Disposing of pesticide wastes						Assisting State regulatory agencies in establishing regulatory programs						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																																	
USOA																																		
Existing	13.00	65.55	.76	16.65	--	--	28.18	140.98	10.39	39.03	--	--	4.62	23.40	2.65	13.25	--	--	.11	.95	.60	3.65	--	--	.03	.25	.57	2.85	--	--	45.94	231.13	14.97	75.43	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
OHEW																																				
Existing	7.50	39.81	2.16	9.41	--	--	--	--	.22	1.19	--	--	--	--	(2)	(2)	--	--	--	--	.02	.10	--	--	--	--	.07	.59	--	--	7.50	39.81	2.47	11.29	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USOI																																				
Existing	1.73	11.75	.65	3.60	--	--	.06	.95	--	--	--	--	.08	1.20	--	--	--	--	--	--	--	--	--	--	--	--	.25	1.70	--	--	1.87	13.90	.90	5.30	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																																				
Existing	22.23	117.11	3.57	29.66	--	--	28.24	141.93	10.61	40.22	--	--	4.70	24.60	2.65	13.25	--	--	.11	.95	.62	3.75	--	--	.03	.25	.89	5.14	--	--	55.31	284.84	18.34	92.02	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

2/ Program expenditures are less than $0.01 million annually.

AIR POLLUTION IN RELATION TO AGRICULTURE

The relationship of air pollution to agriculture poses an interesting paradox. On the one hand air pollution causes damage to crops, forests, and animals; on the other hand certain agricultural activities, such as burning wastes and processing products, produce air pollution.

In view of this situation plus the fact that air pollution has become a problem of great national concern, it was felt that this report should cover both the effects of air pollution on agriculture and the production of air pollution by agricultural enterprise. Accordingly, the report has been written in two parts. Part One deals with the effects of air pollution on plants and livestock and Part Two deals with air pollution produced by various agricultural activities. The last part of this section of the report is common to both Part One and Part Two.

Air-pollution problems related to pesticides are covered in the chapter on that subject and are not discussed under air pollution.

AIR POLLUTION IN RELATION TO AGRICULTURE

Part One - Effects on Plants and Livestock

I. The Problem

Background

Air pollution can cause both acute and chronic injury to crop plants, ornamentals, trees, and livestock. In southern California, acute injury to vegetation is widespread. About 14,000 square miles in that State are now affected by airborne toxicants. There is increasing concern that the entire Central Valley of California is threatened by air pollution. Losses in the State have been estimated at $132 million annually. Injury from photochemical air pollution has been reported from at least 27 States and probably occurs, to some degree, in all States. Nationwide losses to agriculture and forestry because of noxious chemicals in the atmosphere are estimated at $500 million or more.

The concentration, transportation, and dispersion of air pollutants from the various sources are influenced by topography and meteorological conditions. During periods of atmospheric stagnation contaminants are inadequately mixed with the air mass. Inversions that effectively suppress vertical mixing and lead to severe pollution problems in large industrial and metropolitan areas occur frequently. Under such conditions, potentially lethal layers of toxicants can become entrapped for days, and damage to exposed plants and animals can be severe.

Different air contaminants have specific effects on agricultural crops and forest trees and are best treated as distinct parts of the overall problem.

Problem areas

Sulfur dioxide. Sulfur is a required plant nutrient, part of which comes from the atmosphere. But concentrated emissions can be very destructive. Twenty-six million tons of sulfur dioxide are emitted into the atmosphere over the United States every year, primarily from the combustion of fossil fuels. One example of the drastic effects excessive sulfur dioxide contamination can have still prevails at Copper Basin around Ducktown, Tennessee. Before 1900 this basin in the southern Appalachian Mountains was covered with hardwoods and some conifers.

Open-hearth furnaces installed at mine locations were most active from 1890 to 1895. Soon after 1900, the sulfur dioxide fumes killed most of the vegetation in the basin. White pines 30 miles from the smelters were killed. Even today some 7,000 acres to the leeward of the smelters are devoid of vegetation. Erosion has been intense. Another 17,000 acres surrounding the denuded area are devoid of trees.

Injury to vegetation depends on concentration in the atmosphere, length of exposure, wind speed, and other aerometric factors, and tolerance of the species. Alfalfa, wheat, and conifers are relatively sensitive to SO_2, whereas potatoes, corn, and maples are more tolerant. If the SO_2 content of the air is 0.3 to 0.5 parts per million (ppm) for several days, sensitive vegetation will be injured.

Fluorides.--Airborne fluorides have become a serious toxicant to vegetation and indirectly to animals. The industries mainly responsible are aluminum reduction, smelting of iron and nonferrous metals, ceramics, and phosphate-rock processing for fertilizers. Manufacturers have made some progress over the last decade in installing equipment to curb fluoride effluent, yet the problem continues because not all fluorides can be removed and levels of 1 part per billion (ppb) or less can cause serious problems. Fluorides appear to act as cummulative poisons in plants and as such they cause serious losses in growth or death. In 6 days, corn foliage has concentrated 5 ppb of atmospheric hydrogen fluoride to a concentration of 178 ppm on a dry-weight basis. Gladioli, Italian prunes, peaches, and grapes are also sensitive to low levels of hydrogen fluoride. More than 500 ppm of fluoride can be concentrated in some foliage during a single season from atmospheric fluoride levels of 0.5 ppb. Fluoride injury on Ponderosa pines has been detected 20 miles from an aluminum smelting plant.

Chronic fluorosis may develop in livestock from ingestion of small amounts of fluoride over several months or years. Eating contaminated forage grown near industrial areas emitting fluorides can induce fluorosis. If the animals receive a mineral mixture or water containing fluoride, the effect of the contaminated forage is accentuated. Cattle are most sensitive, followed by sheep, swine, horses, and poultry. Cattle can ingest about 1 milligram of fluorine per kilogram of body weight per day without harmful effects if they are in good health. Symptoms of fluorosis, which occurs when the diet contains more than 30 to 40 ppm of fluorides per day, include excessive wearing of the teeth, staining, pitting of the enamel, and exposure of the dentine. In severe cases, joints may become enlarged and bone density increases significantly.

Photochemical oxidants.--Based on current information, peroxyacetyl nitrate (PAN) and ozone are the primary toxicants in smog resulting from photochemical reactions. Compounds closely related to PAN exist and the entire family of compounds are known as peroxyacetyl nitrates (PANS). There are many sources of compounds that react in the presence of sunlight to produce PAN and ozone, but automobile exhaust is the major contributor.

PAN is extremely toxic to citrus, forage, salad crops, ornamentals, and coniferous trees. Acute leaf damage by PAN to sensitive species has been observed at 0.03 ppm in the air. PAN tends to produce injury symptoms on the lower surface of leaves, whereas ozone causes injury to the upper surface, retards growth, and stimulates leaf abscissions. Crops of romaine lettuce have been completely destroyed by PAN. Cigar-wrapped tobacco grown beneath cloth shade, as in the Connecticut Valley and Florida, has been seriously damaged by "weather fleck" due to ozone injury. Sensitive plant species such as tobacco, alfalfa, and white pine may be damaged after exposure to 0.06 ppm ozone for 3 to 4 hours.

Both PAN and ozone have proved highly injurious to ponderosa pine in southern California.

Oxides of nitrogen.--Nitrogen oxides are produced by high-temperature combustion, thus they may be emitted by any fuel-combustion source. On sensitive plants nitrogen dioxide causes irregular blotches of collapsed tissue near the edge of the leaves. Pinto beans and tomatoes show reduced growth and leaf distortion when exposed to 0.5 ppm of nitrogen dioxide for 10 to 22 days. Most of the time, concentrations of nitrogen dioxide in the atmosphere near sources of effluent are below 0.3 ppm.

Ethylene.--Cotton plants growing downwind from industrial establishments making polyethylene have been found to be seriously damaged by ethylene-contaminated air containing as much as 3 ppm of ethylene. The injury was identical with that artifically induced by 3 ppm of ethylene in the laboratory. Ethylene in the atmosphere, attributed primarily to emissions in auto exhaust, has caused considerable loss to orchid growers. Exposure for 6 hours at 0.05 ppm causes sepal damage to Cattleya orchids. Carnation flowers often fail to open after a 6-hour exposure to 0.1 ppm ethylene.

Lead compounds.--In the middle twenties, tetraethyl lead began to be added to gasoline, enabling use of engines with higher compression and higher efficiency in energy conversion. Since that time, millions of pounds of lead have been poured into the atmosphere from motor-vehicle exhausts. Most of this was eventually deposited on soils and plants. In Los Angeles, the average air concentration is 2.5 micrograms of lead per cubic meter of air.

Pasture grasses collected at the intersection of two U.S. highways near Denver contained 3,000 ppm lead, while grasses collected next to a less-traveled roadway contained 700 ppm. Grasses collected 50 to 100 feet away from the latter road contained 5 to 50 ppm of lead.

The lead content os such forage is a potential hazard to the health of livestock.

Salt injury.--There are many problems in establishing and maintaining vegetation along major highways. Not only are plants affected by the exhaust from motor vehicles, but in some areas it is known that salt used for deicing creates additional problems with respect to vegetation. Although most of the salt goes into runoff, some becomes an airborne liquid aerosol, causing injury to trees and other vegetation receiving the deposit.

Combination of pollutants.--The effects of combinations of pollutants need investigation. Most studies have been concerned with the effects of individual pollutants, even though several pollutants are known to be present in contaminated air. The recent evidence of synergistic action of ozone-sulfur dioxide and nitrogen dioxide-sulfur dioxide further emphasize the need for more research in this area.

Particulates.--Natural and industrial dusts coat the foliage of crops, ornamentals, and trees, impairing growth and quality of the product. Leafy vegetables, small fruits, and ornamentals are especially damaged by dusts. Dusts contribute to respiratory ailments of man and animals, affect highway and air vision, damage machinery, and permeate buildings. Pesticides can be carried long distances on natural dusts and can be carried to farm ponds and tributary streams used for recreation. Herbicides carried in this manner may cause crop damage. Airborne dusts from agricultural endeavor may therefore be of serious concern.

The nature of the air-pollution problem as it affects agriculture and forestry is more complex than is indicated by this brief discussion. It is difficult to separate the effects of air pollution from injury by diseases, insects, and such physiological stresses as cold temperature and drought. Improved methods must be developed to evaluate the nature and extent of air-pollution injury if we are to get a dependable assessment of economic losses. Only some of the problems related to auto exhaust and other fuel combustion have been identified.

II. Methods and Effects of Control

Probably the most logical approach to control of air-pollution damage is at the source of the pollutant materials, i.e., at the smelter, the refinery, the power plant or the internal combustion engine, but this is primarily a nonagricultural job and is not dealt with here. But a more complete evaluation of total economic impact to agriculture is needed nationwide as a basis for better air-quality standards and controls. Undoubtedly it would stimulate greater effort to prevent toxic emissions.

There are also several possible controls that may be feasible for application onsite by land owners or managers--

1. Natural variability in resistance or susceptibility of certain plants to some pollutants is known to exist. Thus, resistant strains or varieties can be developed.

2. There is some evidence that the degree of pollution damage can be modified by altering soil fertility or moisture levels.

3. Careful site selection to avoid exposure of susceptible species to known pollutants can reduce losses.

4. Some crop damage by particulates, and perhaps by aerosol and gaseous pollutants, can be reduced by vegetation screens of nonsusceptible species of trees or shrubs.

5. Greenhouse crops can be protected from most air pollutants by using activated carbon filters.

The current level of knowledge about air-pollution damage to crop plants and trees does not permit operational use of any of these controls except using resistant varieties of cigar-wrapper tobacco. Considerably more knowledge is needed on the nature and extent of damage, natural variation in susceptibility, and environmental relationships.

Part Two - Agricultural Sources of Air Pollution

1. The Problem

Most of the air-pollution sources that can be classified as agricultural have been described to some extent in the preceding sections of this report. In this section all such sources are treated as a group, and an idea of the relative importance of agricultural sources in the total air-pollution picture is discussed.

Before discussing the problem of agricultural pollution sources, perhaps it would be instructive to define, to some degree at least, what is meant by "air pollution" or what constitutes an "air pollutant." In general, air pollution occurs if some undesirable substance is present in the air that we use. Such undesirable substances are called air pollutants and include a broad range of materials in all states--gaseous, solid, and liquid; inorganic and organic. Examples of common pollutants are dust particles, sulfuric acid mists, carbon monoxide, sulfur dioxide; ozone, allergenic pollens, and hydrogen sulfide.

Table 4 shows the estimated annual tonnage production for five major pollutant categories by principal source.

From this table it appears that motor vehicles are the greatest producers of air pollution in the country, accounting for more than 60 percent. Motor vehicles are also the greatest source of hydrocarbons and nitrogen oxides, and industry and power generation produce the bulk of sulfur oxides and particulate matter. Atmospheric photochemical reactions primarily involving nitrogen oxides and hydrocarbons produce ozone, PAN, and other pollutants. Products of these emissions are not included in the table even though they are major pollutants.

Although emissions from agricultural sources, other than pulp and paper mills, are not included in table 4, perhaps we can gain some perspective by looking at one source of agricultural air pollution--forest fires. The U.S. Forest Service estimates that wildfires alone add some 37 million tons of particulate matter per year to our atmosphere and that slash (logging debris) burning and prescribed forest burning add another 17 million tons for a total of more than 54 million tons of particulate matter. This is more than three times the amount emitted by other stationary and automotive sources. On the other hand, forest burning produces less than a half million tons of hydrocarbons and probably negligible quantities of sulfur oxides.

Table 4.--Annual Air Pollutant Emissions From Major Industrial and Urban Sources[1]

Source	Carbon monoxide	Sulfur oxides	Nitrogen oxides	Hydro-carbons	Particulate matter	Total
			(millions of tons)			
Motor vehicles-----	66	1	6	12	1	86
Industry[2]----------	2	9	2	4	6	23
Power generation--------	1	12	3	1	3	20
Space heating[3]----	2	3	1	1	1	8
Refuse disposal[4]--------	1	1	1	1	1	5
Total---------	72	26	13	19	12	142

[1]The Sources of Air Pollution and Their Control, Public Health Service Publications No. 1548. 1966

[2]Includes pulp and paper manufacturers, iron and steel mills, petroleum refineries, smelters, inorganic and organic chemical manufacturers.

[3]Heating for homes, apartments, and offices.

[4]Municipal, commercial, and home incineration.

To describe properly the problems of air pollution we must consider more than just the quantities of pollutants emitted--we must take into account the transport of pollutants and their dilution in the atmosphere plus the exposure of receptors, such as people, animals, vegetation, and materials to these pollutants. In forest fires, much of the smoke may be carried up in the convection column and eventually be dispersed without affecting receptors. In addition, many of the larger wildfires occur in remote areas where few sensitive receptors are located. On the other hand, even a small forest fire burning under fairly stable wind conditions may produce serious visibility problems if it is near a main thoroughfare.

Burning of residues.--As indicated in the example of forest fires, the effluent from burning of agricultural and forest residues probably contributes a significant part of the particulate matter in our atmosphere. At present, burning is the easiest and usually the most economical method of disposing of the large volume of waste vegetable matter that accumulates each year on forests, farms, and rangeland. In addition to providing a convenient means of waste disposal, crop residues are burned to control the spread of infectious agents and insects. Fire is used as a forest-management tool in reducing the hazard of wildfire and for site preparation, improving wildlife habitats, and controlling diseases and insects.

The principal impact of burning is in the reduction of visibility. Automobile accidents in southeastern United States have been attributed to smoke from prescribed forest burning. The reduction in esthetic enjoyment may be significant in scenic areas. For example, tourists who come to the Far West expecting to view a vast reservoir of natural beauty sometimes discover only a pall of smoke and haze.

Windblown soil.--Large volumes of soil are lifted by the wind each year and distributed throughout the atmosphere for great distances. Much of this dust comes from plowed land and causes occasionally serious visibility reduction, eye irritation, respiratory discomfort, soiling, fouling of electrical and mechanical devices, and obstruction of transportation and drainage.

Livestock and poultry operations.--Odors from feedlots, dairies, pig farms, and chicken houses are well known to those who have been near them and constitute one of the chief bases for complaints against such enterprises. The main source of such odors is fecal matter deposited by the animals. It is estimated that over a billion tons of solid fecal matter per year are produced by livestock and poultry in this country.

Under modern concentrated animal- and livestock-rearing practices manure is no longer an economic byproduct and its use as fertilizer is very limited. Until feasible methods are developed for utilizing or deodorizing animal manure, we can only expect a worsening of this critical odor problem. In addition to the odors emanating from animal waste, dust from feedlots, stockyards, dairy farms, and poultry operations are easily airborne and add to the general inventory of windblown particles.

Cotton ginning.--The waste or trash from cotton gins consists of soil particles, pollen, fungi, fibers, pesticide residues, and other organic materials. These materials litter the vicinity of the gin and are a nuisance to those who live nearby. About half of the waste is emitted through exhaust blowers and the remaining trash is burned at the gin, producing effluent in the form of smoke. It is estimated that incineration of cotton-gin trash emits 375,000 tons of particulate matter each year.

Pulp and paper manufacture.--More than 33 million tons of wood pulp are produced each year in the United States. Of this, more than 20 million tons are produced by the sulfate or kraft process. Kraft pulp mills produce one of the foremost air-pollution problems in the country. Odors (hydrogen sulfide and methyl mercaptan) produced by kraft mills are particularly offensive. Hydrogen sulfide is also highly corrosive, attacking paints and metals. In addition, significant concentrations of particulate matter and sulfur dioxide may be emitted. Other pulping methods such as ground-wood and sulfite processes, although they produce some pollution, are not considered as serious problems if compared with the kraft process.

Citrus-feed dryers.--The waste peel, rag, and seeds recovered from processing oranges and grapefruit for juice in Florida can be converted into dried citrus feed and citrus molasses. This is now a sizable industry with an annual production of 422,000 tons of feed and 56,000 tons of molasses. Particulate emissions from the dryers are producing a serious air-pollution problem in certain Florida communities.

Animal-products processing.--Perhaps the most noticeable air-pollution problems connected with processing animal material center around rendering plants, which characteristically produce an extremely foul odor. Odors from slaughtering and packing houses are noticeable but are not so offensive as those from rendering plants. A recent interstate abatement action involved odors from a plant that manufactures animal-food supplement from chicken-processing waste.

Sawmill waste.--The burning of waste material from sawmilling and veneering produces a smoke problem because of the inefficient method of incineration ordinarily employed. More than 14 million tons of wood residue from lumber manufacture are burned each year. The principal impact of this source is reduced visibility.

Other combustion processes.--Usually associated with the larger processing plants such as pulp mills, large sawmills, packing houses, and food-processing plants are steam boilers employed in power or heat production. The power and steam plants are usually smaller than the large utility power plants but may emit significant amounts of particulate matter and sulfur oxides when fired with coal or fuel oil.

Other processing operations.--Storage, transport, and milling of grains produce significant amounts of grain dust which if not controlled reduce visibility and produce respiratory discomfort. Dust from castor oil production may produce a very severe allergic condition in people.

Airborne allergens.--Over 12 million people in the United States suffer from hay fever and asthma. Practically all hay fever and a significant proportion of asthma attacks can be attributed to airborne pollen from ragweed, grasses, and other plant species. Annual medical costs due to pollen allergies may run as high as 300 million dollars per year. Although the allergenic role of spores from certain species of fungi and bacteria is yet poorly understood, present evidence indicates that such spores can produce reactions similar to those of pollen.

II. Methods and Effects of Control

Generally speaking, those sources of air pollution associated with the production end of agriculture and forestry are more difficult to control than those associated with the processing of products. Processing activities are usually centralized whereas production activities are not.

While, in general, the brief comments on the various sources of pollution which follow relate to after-the-fact control, it should be clearly recognized that the efficacy of alteration of processes is an area requiring considerable exploration. Such exploration in future years may result in economical processes generating little or no pollutants.

Burning of residues.--Burning of residues may be restricted to periods when the weather is sufficiently unstable for favorable transport and dilution, but this is possible only during a limited part of the burning season. The critical question here is what alternative methods are available or can be developed to accomplish what burning seems to do so well. Some chipping of forest slash can be done in the woods, but this is still on a small scale and requires special market conditions. To control diseases from seed, grass, and other residues would presently require very expensive chemical methods. Cost-benefit studies to explore alternative methods in terms of net benefits from reduction of air pollution, plant disease, and wildfire should be conducted. Although prescribed forest burning produces visability problems, it may in fact be reducing them by reducing the acreage burned by wildfires.

Windblown soil.--Present management practices have greatly decreased the amount of soil eroded from farm and grazing land since the dust-bowl days of the 1930's. Planting of trees and shrubs for windbreaks and shelterbelts has long been a recommended practice. Improved methods, machinery, or chemicals are needed to improve soil stability and reduce wind erosion. The use of suitable cover crops will protect fallow land, but much can be gained by developing new strains of plants for cover.

Livestock and poultry operations.--The problem here is finding a way to control odor and dust at the site and to provide for disposal of fecal material. No feasible methods are now on the market, but many ideas are being considered. Treating the manure with chemical deodorants may provide a partial solution. The larger problem of getting rid of the material is far from solved.

Cotton ginning.--Methods of controlling air pollution from cotton gins have been developed and are economically feasible. The cost of installing suitable control equipment is about $30,000 per gin, but since most rural areas do not have air-pollution ordinances, few controls have been installed.

Pulp and paper manufacture.--Because of the size and importance of the kraft pulp industry a great deal of progress has been made in developing methods of controlling particulates from pulp mills. Nevertheless, the hydrogen sulfide and odor problems still exist along with substantial emissions of particulate matter.

Methods to reduce the concentration of particulates, gases, and odors are available but have not been used in many plants because of the expense. Control appears to be economically feasible in new plants but perhaps not in some of the older ones. Industry cooperation is needed to carry out a control program.

Citrus-feed dryers.--Control would appear to be accomplished very easily but nothing has been done on a large scale as yet. The Department of Agriculture is studying economic aspects of the problem.

Animal-products processing.--This is an extremely difficult area for control because control would be economically unfeasible for many of the older plants. Afterburner-type control devices are available for odor control for some types of rendering cookers, and these can be installed effectively in new rendering plants. The difficulty of controlling odors at most of these installations (or any odor producer for that matter) rests as much on the lack of quantitative standards for odor levels as it does on technological difficulties.

Sawmill waste.--One solution here is to develop a higher degree of utilization to reduce waste, plus market development for waste products. The other and more expensive solution is to install efficient incinerators and use them. A great deal of research has been done on utilization of waste from forest products, but in only a few of the larger mills has complete utilization become a reality.

Other combustion processes.--Particulates can presently be controlled at high efficiency. No feasible method for removal of gaseous pollutants such as sulfur oxides has yet been developed for use in this country. Where available the use of low sulfur fuel will reduce the amount of sulfur oxides.

Other processing operations.--Dusts from grain processing are difficult to control under present procedures. Although significant advances have been made in milling operations, there is need for developing methods to capture dusts in loading operations.

Airborne allergens.--Although many plant species produce allergenic pollen and spores, the ragweeds appear to have the greatest impact on community health. It is for this reason that programs to control airborne allergens have concentrated on eradication of ragweed. Ragweed is very susceptible to chemical herbicides. Current control procedure consists of spraying with herbicide, where practicable, before the ragweed flowers and cutting the ragweed where there is danger of herbicide damage to nearby desirable vegetation. Although ragweed is easily killed, eradication programs have failed to cause any appreciable reduction in hay fever attacks. Additional research is needed to determine the extent of ragweed control necessary to cause a significant reduction in hay fever and other allergy attacks.

Although considerable research has been done concerning the effects of air pollution on plants and animals and the control of pollution from agricultural sources, significant gap areas still exist. The following areas of emphasis indicate where additional effort is needed to remedy the major deficiencies in our present state of knowledge and capability.

1. Measurement and monitoring of air pollutants

Under the Air Quality Act of 1967 (PL 90-148) the Department of Health, Education, and Welfare is responsible for developing new and effective methods of measuring air pollutants. At present DHEW has several projects devoted to research and development in the area of chemical and physical analysis and instrumentation.

The Department of Agriculture is conducting research to learn how to use plants, especially coniferous tree species, as living monitors for detecting and indicating different levels of specific chemical air pollutants. Studies have recently been started to determine possibilities of remote-sensing techniques for detecting and identifying specific pollutant injury to vegetation. More versatile and more sensitive methods of making chemical analyses of plant tissues for minute quantities of pollutants, and for studying physiological damage caused by them, need to be developed.

An organized effort is needed to establish air-pollution monitoring networks in agricultural and forest areas where present or potential damage exists. An assessment should be made of background levels, especially of photochemical oxidants, and the interface between urban and non-urban areas. For example, the entire Central Valley of California and much of the surrounding mountain area used for timber and recreation is being threatened by photochemical smog. The Department of Agriculture anticipates monitoring emissions from industrial mineral-processing plants operating on National Forest land under Special Use Permits to insure compliance with standards established under the Air Quality Act of 1967.

2. Effects on plants and animals

The Department of Agriculture and the Department of Health, Education, and Welfare are presently conducting research in this area. There are several cooperative projects between the two departments. Although major attention is being given to immediate effects of air pollution on plants and animals, increasing emphasis is being placed on the long-term effects of low concentrations of pollutants singly and in combination. This involves research in basic biochemical and physiological mechanisms as well as in field methods to detect and measure such injury.

3. Economic impact

Present estimates of economic losses due to air pollution are based on very sparse data. Research is needed to develop more accurate methods of assessing economic damage to crops, forests, and livestock. At present the Departments of Agriculture and Health, Education, and Welfare are developing ways to assess crop and forest damage through various methods including the use of remote-sensing devices. Remote sensing from aircraft, supplemented with ground information, should provide a method of rapidly detecting and measuring air-pollution damage for subsequent translation into economic values. The remote-sensing system is needed to provide for a comprehensive economic analysis. But pending development and installation of this system, economic research is needed on smaller areas that are severely affected by air pollutants. These analyses would assist in resolving pollution problems while maintaining the relative efficiency levels of the economy.

4. Genetic and environmental control

The Department of Agriculture has current and planned research programs on selection and breeding of crops and trees resistant to air pollutants and on development and use of filter systems. The ability of vegetation in buffer zones to "filter out" air pollutants requires further study as does the development of efficient filter systems for greenhouses and animal houses.

Partial alleviation of the air-pollution problem may be effected through selection and breeding of resistant plants and animals and by manipulation of environmental factors to increase resistance. Considerable research will be required in this area before action programs can be initiated.

5. Control of agricultural air-pollution sources

The Department of Agriculture in cooperation with the Department of Health, Education, and Welfare is currently studying ways of reducing emissions from combustion processes, such as burning of crop and forest residues, and elimination of odors from animal wastes. DHEW, under the Air Quality Act of 1967, is conducting research on methods of controlling emissions from kraft pulp mills. In addition, DHEW conducts abatement actions where necessary and provides technical assistance and financial aid to State and local governments for control of air pollution from all sources. In fiscal year 1969, DHEW will begin a comprehensive system study of air pollution control technology and economics in the pulp and paper industry and a study of the effect of controlling sources of airborne allergens on the incidence of hay fever and asthma.

The Department of Agriculture is investigating new methods of soil management that help control wind erosion and airborne dust on agricultural land. It has a small research program for developing more effective ways of controlling plants that produce allergenic pollen, and one for reducing the emission of objectionable odors and gases in the manufacture of wood-pulp.

USDA anticipates a major program to provide technical assistance to farmers and ranchers in planning and applying conservation measures to reduce wind erosion. Cost-sharing and land-retirement payments are provided under existing authority. Also included are extension-type activities to disseminate information on dust-control practices. Logging-slash disposal and prescribed burning activities are now being modified to reduce air pollution from smoke.

AIR POLLUTION IN RELATION TO AGRICULTURE

Tabulation of Estimated Federal Funding

Data are presented for Federal programs in FY 1968 and FY 1969 dealing with pollution from air pollutants. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

The USDA 5-year research and development projections do not include costs for facilities to house an expanded program.

Measurement and monitoring of air pollutants

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.12	.18	.23	.29	.29	.34	.40	1.55
DHEW	.50	1.00	1.30	1.30	1.70	2.00	2.00	8.30
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	.02	.04	.07	.30	.50	.80	1.71
DHEW	--	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	--	-
USDI	-	-	-	--	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	--	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Effects on plants and animals

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.06	.14	.24	.36	.50	.50	.48	2.08
DHEW	1.52	1.73	2.51	2.70	2.70	3.20	3.20	14.31
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Economic impact

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.01	.02	.03	.03	.03	.04	.05	.18
DHEW	.02	.19	.20	.20	.15	.15	.15	.85
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	.10	.10	.10	.10	.10	.50
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Genetic and environmental control

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.41	.46	.68	1.04	1.39	1.60	1.87	6.58
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Control of agricultural air-pollution sources

Program and Department	Estimated Federal Funding							
	Current		Projected (year of funding)					
	FY 1968	FY 1969	1st year	2nd year	3rd year	4th year	5th year	5 year total
	(Million dollars)							
Existing Legislation								
Research and Development								
USDA	.58	.64	.81	1.03	1.15	1.32	1.36	5.67
DHEW	.50	.70	1.00	1.50	1.50	1.50	1.50	7.00
USDI	-	-	-	-	-	-	-	-
Action								
USDA	9.80	9.95	11.86	12.27	12.69	13.14	13.64	63.60
DHEW	1.00	2.00	3.00	3.00	3.00	3.00	3.00	15.00
USDI	-	-	-	-	-	-	-	-
Proposed Legislation								
Research and Development								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-
Action								
USDA	-	-	-	-	-	-	-	-
DHEW	-	-	-	-	-	-	-	-
USDI	-	-	-	-	-	-	-	-

Department and Legislation	ricultural air pollution sources					Total					
	ch and pment	Action		Loan Level		Research and Development		Action		Loan Level	
	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
USDA											
Existing	5.67	9.95	63.60	--	--	1.44	16.06	9.97	65.31	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--
DHEW											
Existing	7.00	2.00	15.00	--	--	3.62	30.46	2.00	15.50	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--
USDI											
Existing	--	--	--	--	--	--	--	--	--	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--
TOTAL											
Existing	12.67	11.95	78.60	--	--	5.06	46.52	11.97	80.81	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--

1/ See tables f

Areas of Emphasis--Estimated Funding 1/

Department and Legislation	Measurement and monitoring air pollutants						Effects on plants and animals						Economic impact						Genetic and environmental control						Agricultural air pollution sources						Total					
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																																			
USDA																																				
Existing	.18	1.55	.02	1.71	--	--	.14	2.08	--	--	--	--	.02	.18	--	--	--	--	.46	6.58	--	--	--	--	.64	5.67	9.95	63.60	--	--	1.44	16.06	9.97	65.31	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DREW																																				
Existing	1.00	8.30	--	--	--	--	1.73	14.31	--	--	--	--	.19	.85	--	.50	--	--	--	--	--	--	--	--	.70	7.00	2.00	15.00	--	--	3.62	30.46	2.00	15.50	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
USDI																																				
Existing	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																																				
Existing	1.18	9.85	.02	1.71	--	--	1.87	16.39	--	--	--	--	.21	1.03	--	.50	--	--	.46	6.58	--	--	--	--	1.34	12.67	11.95	78.60	--	--	5.06	46.52	11.97	80.81	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

1/ See tables for the individual Areas of Emphasis for footnotes.

GENERAL DISCUSSION

Concern for the quality of our environment has been growing rapidly in recent years. There is a rising interest in "cleaning up" the environment. The accomplishment of this objective is predicated on how "clean" we want the environment and on how much we are willing to spend. Related political and social considerations are also involved.

The degree of environmental cleanliness desired may vary in different situations. For example, water for most industrial purposes or for irrigation does not have to be as pure as drinking water. These issues are being considered, and environmental-quality standards are being adopted as a basis for action.

A wide variety of decisions must be made among the alternative approaches for resource allocation and among expenditures to alleviate wastes in the environment. Research should include evaluating costs and benefits associated with waste production and disposal. It also should include studying ways to reflect nonmonetary values such as esthetic, spiritual, and other aspects of the quality of the environment.

Socio-economic evaluations can make substantial contributions to decision-making processes by improving the informational base.

Effective management of environmental quality depends on the development of a broad sense of economic and social responsibility and an increased awareness of the short-run and long-run effects of pollutants. Socio-economic inquiry into environmental deterioration establishes the basis for communication and reconciliation among different interest groups, for identification of alternatives, and for choosing the best alternative to enhance the environment in terms of human needs and desires, cost, time, and place. Socio-economic inquiry can define the relationship between specific actions to ameliorate environmental pollution and the attainment of other national objectives, economic needs, and cultural goals.

Like most other activities of man, agriculture contributes to the pollution problem; in fact, the contribution is a significant one. This study was undertaken to obtain some measure of the actions required to cope with the agriculture-related pollution problem. Eight major types of pollutants were selected for consideration. There are others--radiation, allergens, noise, and various living organisms such as bacteria--and they too require attention. But they were excluded arbitrarily to give opportunity for concentration on those areas that were considered most pressing.

One result that emerged from this study was a gross estimate of the order of expenditures that might be anticipated in this area. But an analysis of the combined agency budgets to evaluate the distribution of allocations is fraught with hazards. In the areas of sediment, plant nutrients, forest and crop residues, and inorganic salts and minerals there are particular problems. In each area the part of a total program that can be allocated to agricultural pollution is difficult to ascertain. Activities may have multiple objectives. For example, controlling forest residues not only reduces air and water pollution but also increases production efficiency and helps prevent forest fires. Similarly, controlling sediment prevents pollution, reduces maintenance of harbor facilities, prevents soil deterioration, and improves water quality.

In other instances, techniques may be developed for simultaneous control of several pollutants, and these can have application in urban as well as rural environments. The development of membrane technology, for example, has potential for preventing contamination of water by nutrients, salts, and minerals whether the source is fertilizer, irrigation water, sewage, or industrial wastes.

The following conclusions can be drawn regarding existing and proposed expenditures.

1. In very general terms, which include subjective assumptions about how much of various programs can be assigned to agriculture-related pollution, it appears that proposed agency expenditures in this area would average one billion dollars annually for an initial 5-year period. This is exclusive of Department of Agriculture loan programs.

2. It is estimated that the proposed research and action programs in an average year of the 5-year projection would require an approximate 60 percent increase over current expenditures. Loans by the Department of Agriculture would increase from $23 million to an average of $530 million per year.

3. The Department of Agriculture anticipates larger expenditures than any of the other agencies.

4. Currently, sediment is receiving principal emphasis, and then pesticides. Processing wastes and air pollution are next; the rest run about equal. In order of descending proposed expenditures for support, sediment, animal wastes, pesticides, and processing wastes will receive major attention; somewhat less support is proposed for air pollution. The remaining three--inorganic salts and minerals, plant nutrients, and forest and crop residues--will receive about equal support. The most dramatic change is the acceleration of programs concerned with controlling animal wastes.

These conclusions are based on budgets and legislative authorities proposed by the agencies. There will always be limited resources, and decisions will have to be made individually on the relative benefits that result from each program.

There are additional program requirements associated with the agriculture-related pollution problem in such areas as education and environmental monitoring. These were not emphasized in this study.

Appropriately, considerable emphasis has been placed in recent years on preventing the deterioration of our air and water resources. But there is one additional question that has come up in the course of this review. Soil frequently has been exploited because of both poor agricultural management and urban development. Although conservation of our soil resource has received attention for a considerable period, actions in this area have been principally at the landowner's discretion. The Natural Resources Council of America has proposed the following policy in this area. "Good management, public interest and human welfare require that all landowners, public or private, care for soil and water under their control in a manner that will ensure that future generations may derive from them full enjoyment and benefit....."

This proposal implies that the soil is a national resource as well as a private one. There is considerable merit in this concept. Deterioration of soil through preventable erosion, industrial pollution, or excessive pesticide application, for example, has an impact that extends beyond the rights of the individuals who presently have stewardship. This concept and its implications require further exploration, particularly in view of developing interest in environmental management. Undoubtedly, there is need for a broader approach to rational use of the land resource.

SUMMARY

AGRICULTURE-RELATED POLLUTION

Tabulation of Estimated Federal Funding

Summary data are presented for Federal programs in FY 1968 and FY 1969 dealing with agriculture-related pollution. In addition, a 5-year program is projected. The projected program is based on individual agency assessments of the requirements of a reasonable program needed to make effective progress. The data were assembled without reference to overall budgetary policy.

Pollutant or Carrier and Legislation	U				TOTAL					
	Research and Development		Action	Loan Level	Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
Sediment										
Existing	4.02	33.65	289.2	--	5.43	42.75	527.67	3437.72	7.00	446.00
Proposed	--	--	--	--	--	--	--	322.70	--	--
Animal Wastes										
Existing	1.50	19.84	.7	--	2.43	30.63	1.43	82.02	--	700.00
Proposed	--	--	--	--	--	--	--	810.90	--	1894.00
Wastes from Industrial Processing of Raw Agricultural Products										
Existing	1.84	29.75	.8	--	2.55	32.06	12.86	65.49	2.00	160.00
Proposed	--	--	--	--	--	6.00	--	196.75	--	--
Plant Nutrients										
Existing	1.55	16.40	1.1	--	4.18	16.76	3.67	25.71	--	--
Proposed	--	--	--	--	--	10.55	--	228.54	--	--
Forest and Crop Residues										
Existing	1.41	8.92	24.1	--	1.41	9.27	24.56	160.16	.10	41.00
Proposed	--	--	--	--	--	--	--	14.10	--	--
Inorganic Salts and Minerals										
Existing	1.22	13.39	1	--	2.96	35.55	1.63	17.65	14.00	145.00
Proposed	--	--		--	--	--	--	7.90	--	--
Pesticides in the Environment										
Existing	45.94	231.13	14	--	55.31	284.84	18.34	92.02	--	--
Proposed	--	--		--	--	--	--	--	--	--
Air Pollution in Relation to Agriculture										
Existing	1.44	16.06	9	--	5.06	46.52	11.97	80.81	--	--
Proposed	--	--		--	--	--	--	--	--	--
TOTAL										
Existing	58.92	369.14	342	--	79.33	498.38	602.13	3961.65	23.10	1492.00
Proposed	--	--		--	--	16.55	--	1580.89	--	1894.00

1/ See tables under the individual pollutant or

SUMMARY--AGRICULTURE-RELATED POLLUTION

Pollutant or Carrier and Legislation	Estimated Federal Funding 1/																											
	USDA						OOD						DHEW						USOI						TOTAL			
	Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level		Research and Development		Action		Loan Level	
	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year	1969	5-year
	(Million Dollars)																											
Sediment																												
Existing	4.02	33.65	289.27	2008.05	7.00	446.00	.15	1.00	186.80	1068.37	--	--	--	--	--	--	--	--	1.26	8.10	51.60	361.30	--	--	5.43	42.75	527.67	3437.72	7.00	446.00
Proposed	--	--	--	258.60	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	64.10	--	--	--	--	--	322.70	--	--
Animal Wastes																												
Existing	1.50	19.84	.75	39.78	--	700.00	--	--	--	--	--	--	.49	2.16	--	13.64	--	--	.44	8.63	.68	28.60	--	--	2.43	30.63	1.43	82.02	--	700.00
Proposed	--	--	--	810.90	--	1894.00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	810.90	--	1894.00
Wastes from Industrial Processing of Raw Agricultural Products																												
Existing	1.84	29.75	.86	54.34	2.00	160.00	--	--	--	--	--	--	.46	2.31	--	11.15	--	--	.25	--	12.00	--	--	--	2.55	32.06	12.86	65.49	2.00	160.00
Proposed	--	--	--	10.65	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.00	--	186.10	--	--	--	6.00	--	196.75	--	--
Plant Nutrients																												
Existing	1.55	16.40	1.17	25.49	--	--	--	--	--	--	--	--	.03	.36	.02	.22	--	--	2.60	--	2.48	--	--	--	4.18	16.76	3.67	25.71	--	--
Proposed	--	--	--	8.20	--	--	--	--	--	--	--	--	--	--	--	.11	--	--	--	10.55	--	220.23	--	--	--	10.55	--	228.54	--	--
Forest and Crop Residues																												
Existing	1.41	8.92	24.31	158.91	.10	41.00	--	--	--	--	--	--	--	--	--	--	--	--	--	.35	.25	1.25	--	--	1.41	9.27	24.56	160.16	.10	41.00
Proposed	--	--	--	14.10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	14.10	--	--
Inorganic Salts and Minerals																												
Existing	1.22	13.39	1.63	17.65	14.00	145.00	--	--	--	--	--	--	--	--	--	--	--	--	1.74	22.16	--	--	--	--	2.96	35.55	1.63	17.65	14.00	145.00
Proposed	--	--	--	7.90	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	7.90	--	--
Pesticides in the Environment																												
Existing	45.94	231.13	14.97	75.43	--	--	--	--	--	--	--	--	7.50	39.81	2.47	11.29	--	--	1.87	13.90	.90	5.30	--	--	55.31	284.84	18.34	92.02	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Air Pollution in Relation to Agriculture																												
Existing	1.44	16.06	9.97	65.31	--	--	--	--	--	--	--	--	3.62	30.46	2.00	15.50	--	--	--	--	--	--	--	--	5.06	46.52	11.97	80.81	--	--
Proposed	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL																												
Existing	58.92	369.14	342.93	2444.96	23.10	1492.00	.15	1.00	186.80	1068.37	--	--	12.10	75.10	4.49	51.80	--	--	8.16	53.14	67.91	396.45	--	--	79.33	498.38	602.13	3961.65	23.10	1492.00
Proposed	--	--	--	1110.35	--	1894.00	--	--	--	--	--	--	--	--	--	.11	--	--	--	16.55	--	470.43	--	--	--	16.55	--	1580.89	--	1894.00

1/ See tables under the individual pollutant or carrier topics for footnotes.